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FILED
JUN 09 2011
SECRETARY, BOARD OF
OIL, GAS & MINING

BEFORE THE BOARD OF OIL, GAS, AND MINING
DEPARTMENT OF NATURAL RESOURCES
STATE OF UTAH

In the Matter of the Petition of Genwal Resources, Inc. for Review of Division Order DO10A, Crandall Canyon Mine	**DIVISION'S** **RESPONSE TO GENWAL'S MOTION TO CONTINTUE EVIDENTIARY HEARING** **AND** **MOTION TO MODIFY DIVISION ORDER 10A** Docket No. 2010-026 Cause No. C/015/0032

The Division of Oil, Gas and Mining Responds to Genwal's Motion to Continue hearing and moves the Board to permit it to modify the required long term bonding obligations as set forth in Division Order 10A with an option for an agreement to provide a conditional and incrementally increased amount of financial assurance.

BACKGROUND

This matter is an appeal by Genwal Resources, Inc. ("Genwal") of the Division's August 26, 2010 Division Order 10A ("DO-10A") (Exhibit A) which requires Genwal to take certain actions in response to the occurrence of unanticipated polluted mine drainage from the Crandall Canyon mine. This mine water drainage contains iron in excess of the levels permitted by the Clean Water Act and requires treatment to attain an acceptable level of iron prior to discharge into Huntington Creek. To address this concern and fulfill the Division's statutory obligation to ensure permitted mines meet the requirements the Utah Coal Mining and Reclamation Act , DO-10A required Genwal to: revise the mine permit application to reflect the changed conditions; submit a plan and summary of the costs of treatment; and post a bond in an amount sufficient to cover the potential costs of treating the mine water in the event the flows require long term treatment.

The Division issued DO-10A based on the findings of a Hydrologic Evaluation Study dated June 2010 ("Study") (Attachment to Exhibit A). This Study was conducted in part to evaluate claims made March in 2009 by Genwal's hydrologist, Erik Petersen, that the iron discharge would naturally diminish. The Division's Study considered the mine's geology, hydrology and other factors to make an in-house evaluation of the mine drainage characteristics and the potential the high-iron discharge would continue. Additionally, the Division has conducted a supplemental evaluation of the mine water drainage and provided Genwal a copy of this report on June 2, 2011. (Exhibit B)

Genwal filed its appeal challenging both the factual basis for the DO-10A and the legal authority for the Division to require a bond for long-term water treatment. The parties proposed the legal issues and factual basis for the Division Order be heard separately. The Board entered an order approving the stipulation. In January 2011, at its regularly scheduled hearing, the Board heard arguments regarding the legal authority under the Utah Coal Mining and Reclamation Act (Utah Code Ann. §§ 40-10-1 to 27(2011)) and regulations (Utah Administrative Code §§ R645-100 et seq. (2011)) for the

Division to require Genwal to post a form of financial security sufficient to cover the costs of long term water treatment.

In lieu of ruling on the legal issue, at the February hearing the parties met with the Board and were asked to take 90 days to see if a settlement could be reached

RESPONSE TO GENWAL'S MOTION TO CONTINUE

After good faith efforts to negotiate, the parties were unable to reach a settlement within the 90 days allotted by the Board.

At the regularly scheduled May 2011 hearing, the Board issued an order requesting for the June 22, 2011, hearing the parties either present a settlement or proceed with the hearing on the technical issues related to the potential for continued contaminated mine water discharges.

Genwal has submitted a motion requesting: 1) the period for negotiations be extended to June 22, 2011; 2) if no settlement is reached, then a order from the Board by July 27,2011 ruling on the legal issues presented in January; and 3) if the case is not dismissed, time to conduct discover and expert analysis for the evidentiary hearing to be held on August 24, 2011.

The Division has had further discussions with Genwal and while a settlement is always possible, based on the current positions of both parties, the Division believes a settlement is neither likely nor imminent at this time. Accordingly, as directed, the Division is willing and prefers to proceed at the June 22, 2011 hearing with a presentation of the technical data supporting the need to require a long-term bond for water treatment.

MOTION TO AMEND THE DIVISION ORDER

Genwal has also asked the Board to rule on the legal issue of whether the Division has the authority to ask for the bonding requested in the DO-10A prior to hearing technical testimony regarding the hydrologic potential for continued long term water treatment. While the Division believes that DO-10A is fully supported by the legal authority as argued in its brief and at oral argument, the Division also believes alternative bonding formulas also may satisfy the Division's regulatory duties. The Division has consider an alternative option for addressing the bonding needs for current water treatment costs that is conditional on the iron levels in the untreated discharge water over time and incrementally builds a long-term bond accordingly

Based on this evaluation, the Division is asking the Board, as part of its consideration of this appeal, to permit the Division to modify DO-10A. The modification proposed by the Division would allow Genwal, subject to Board approval, to satisfy and replace DO-10A's requirement that Genwal post an amount sufficient to cover long term treatment costs by October 15, 2010, with an agreement to provide an initial payment or bond in an amount based on a multiple of the actual annual water treatment a costs, and also commit to making conditional and incremental adjustments to this bonding obligation to be paid over time based on levels of the iron concentrations. The Division is currently only asking for leave to amend the DO-10A in order to reduce into writing the Division's alternative bonding option so it can be considered by the Board. If leave to amend DO-10 is granted, a modification will be filed and the Division would ask the Board to consider the additional option in the amended DO-10A as part of its further consideration of the Genwal appeal.

As much of the amended bonding option is based on technical data, the Division believes the Board should not approve of the modified DO-10A until after it hears the testimony regarding the causes of the discharge, the reasons for the high iron levels and the potential for continued high iron discharges to be presented in the technical hearing contemplated in the October 2010 stipulation. After hearing the technical testimony, the Board could approve the alternative bonding option in DO-10A, or rule that the option is not an acceptable alternative, and require the full bonding as originally set forth in the DO10A. In the alternative, the Board may also decide to grant Genwal's appeal and rule that no bonding is required or authorized. However, the Division strongly feels that prior to approving Genwal's motion, the Board would benefit from understanding the factors that influence the iron levels.

Accordingly, the Division is asking the Board to allow the Division to proceed with the second technical hearing before deciding on the legal authority. At the conclusion of that hearing it can decide to authorize the Division to modify its DO-10A to include an alternative bonding option that reflects this technical data.

ARGUMENT SUPPORITNG DIVISION'S MOTION TO AMEND D0-10A

The Division is of the opinion it has demonstrated in the memoranda filed and in oral argument that there is adequate legal authority under the Utah Coal Act and regulations to require full cost bonding for potential treatment cost of unanticipated pollution discharges from the Crandall Canyon Mine. However, the Division has examined actions taken by the regulatory authorities in other states under similar circumstances and has found other bonding mechanisms that have been employed. The Division believes that the Act may, under certain circumstances, permit a regulatory authority to allow an operator a period of time (up to ten years) to make periodic payments in order to accumulate a fund that would serve as a full-cost bond for long term water treatment. Such an arrangement would be subject to the operator continuing to treat the discharge and meet water quality standards and other conditions. Such agreements have been found to be consistent with the Surface Mining Reclamation and Control Act by the Office of Surface Mining ("OSM") and approved by state programs.

The Division agrees that despite its technical Hyrdologic Evaluation reports and analysis supporting its finding that the pollutional discharge will continue to require treatment over a long time period, there is no certainty about this. It is possible the high iron levels in the mine discharge may naturally diminish. If the levels decrease and remain within the water quality standards for a substantial period of time, the Division agrees there would be no basis for continuing to hold a bond for post-mining treatment costs. In addition, the degree of certainty regarding the long-term nature of the discharges and the need for a long-term treatment bond will increase over time.

Accordingly, based on these assumptions, the Division is seeking approval to allow it to modify its DO-10A to allow Genwal to enter into a conditional and incremental bonding agreement. The modified DO-10A would allow Genwal to begin with a smaller bond sufficient to cover a few years of current costs of treatment. This interim bond would be subject to annual increases if the iron levels do not decline. These increases would build towards a surety sufficient to cover long-term treatment costs. If iron levels decrease and ultimately disappear, the interim bond would be subject to cancellation. In addition, the modified DO-10A option would include a deadline for submitting a design for a long-term treatment facility and additional bonding to cover the cost of construction if such a facility is not completed by the deadline.

Amendment of DO-10A is appropriate since it expands the options for Genwal to meet its bonding requirement. The motion should not raise any new objections by Genwal since it does not increase its obligation to bond for long-term water treatment but merely the form of the bond. Moreover, the amendment provides a less onerous way for Genwal to post a bond sufficient to cover the total costs of long-term water treatment if necessary.

REQUESTED ACTION

Since the Division's proposed modification of the DO-10A would establish a bonding requirement that is dependent on the potential for continued iron pollution and required treatment, the Division proposes the Board hold in abeyance its decision on the legal authority to require full cost bonding until it hears the Division's and Genwal's experts' reports and testimony regarding the hydrologic conditions and technical basis for determining if there is a reasonable potential that iron discharge will continue.

At the conclusion of the technical hearing the Board can either approve the original DO-10A or agree that the presubmitted amended DO-10A, is appropriate and approve it. The amended DO-10A would eliminate the need for a third hearing on the type and amount of bond.

If the Board agrees to grant the motion to amend DO-10A the Division would join in the motion to continue the hearing until August Board hearing.

Respectfully submitted this 8 day of June, 2011

Steven F. Alder
Emily E. Lewis
Assistants Utah Attorney General
Counsel for Utah Division of Oil Gas and Mining

CERTIFICATE OF MAILING

The Undersigned certifies that a true and correct copy of the foregoing Division's Response to Petitioner Motion to Continue was sent to the following persons both electronically and by first class mail this 8 day of June, 2011

Denise Dragoo,
Snell & Wilmer
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Salt Lake City, Utah 84101;
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Salt Lake City, Utah 84111
kanderson@fabianlaw.com
Attorneys for Genwal Resources Inc.

Exhibit A

Division Order 10A
with
June 10, 2010
Hydrologic Evaluation

N

COPY

Outgoing
C0150032
#3603
ok

State of Utah
DEPARTMENT OF NATURAL RESOURCES
Division of Oil, Gas & Mining

JON M. HUNTSMAN, JR.
Governor

GARY R. HERBERT
Lieutenant Governor

MICHAEL R. STYLER
Executive Director

JOHN R. BAZA
Division Director

August 16, 2010

David Hibbs, President
Genwal Resources, Inc.
P.O. Box 910
East Carbon, Utah 84520-0910

Subject: Division Order to Address Mine Water Discharge and Provide Adequate Bonding, Genwal Resources, Inc., Crandall Canyon Mine, C/015/0032-DO10A, Outgoing File

Dear Mr. Hibbs:

In response to an unexpected and un-permitted post-mining discharge of water from the Crandall Canyon Mine, and subsequent pollution of that water with elevated iron levels, Genwal Resources, Inc. was issued two separate Division Orders. Those orders, DO08A and DO09A, have been revised as new information has been gathered regarding the discharge. The attached document, DO10 A, supersedes all versions of both DO08A and DO09A.

You must comply with this Division Order and all deadlines therein or you may be subject to issuance of a Cessation Order, pursuant to Administrative Code R645-400-300 and Utah Code §40-10-22(1)(b) and be subject to further enforcement actions and penalties.

We suggest that Genwal Resources, Inc. apply all possible resources in order to comply with this order. The Division does not anticipate granting any further extensions to the deadlines contained in this order. Upon determination of the amount of surety the Division will provide notice and opportunity for an informal conference as provided for by R645-301-830.420.

DO10A is issued pursuant to R645-303-212. Within thirty (30) days of your receipt of the order you may make a written appeal of the provisions therein to the Board of Oil, Gas and Mining, as provided for by Utah Administrative Rules R645-303-213 and R645-300-200.

File in:
☐ Confidential
☐ Shelf
☒ Expandable
In C/0150032, Outgoing
Date: 08162010a For additional information

If you have any questions regarding this order, please contact Dana Dean at (801) 538-5320. If you have legal concerns, your counsel may wish to speak with Assistant Attorney General Steve Alder at (801) 538-5348.

Sincerely,

John R. Baza
Director, Division of Oil, Gas and Mining

JRB/DD/sqs
cc: Dave Shaver
Jim Fulton
Christine Belka
Denise Dragoo
Steve Alder
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STATE OF UTAH
DIVISION OF OIL, GAS AND MINING

<table>
<tr>
<td>PERMITTEE

David Hibbs, President
Genwal Resources, Inc.
P.O. Box 910
Price, Utah 84520-0910

PERMIT NUMBER C/015/0032
DIVISION NUMBER DO10A</td>
<td>ORDER & FINDINGS
OF
PERMIT DEFICIENCY/INADEQUATE BONDING</td>
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PURSUANT to R645-303-212 and R645-301-830.410, the DIVISION ORDERS the PERMITTEE, Genwal Resources, Inc., to make the requisite permit changes enumerated in this Order to address the Findings of Permit Deficiency, and to post additional bond in order to be in compliance with the State Coal Program. These deficiencies are to be remedied in accordance with R645-303-220.

FINDINGS OF PERMIT DEFICIENCY/INADEQUATE BONDING

1. The Crandall Canyon Mine experienced catastrophic coal bursts and subsequent collapse of the strata above the mine workings on August 6 and 16, 2007. Genwal Resources, Inc. subsequently closed the mine and placed stoppings in the portals.

2. Genwal Resources, Inc. has a valid permit that is in a period of approved temporary cessation. The temporary cessation status does not relieve the permittee from compliance with permit conditions (R645-301-515.310), and in particular the permittee must continue water treatment operations (R645-301-515.321)

3. The BLM approved a revision to the Resource Recovery and Protection Plan (R2P2) for the Crandall Canyon Logical Mining Unit on March 30, 2010. The revised R2P2 states that mining will resume in 2012.

4. In January of 2008, water began discharging from the north portals due to gravity flow. The approved Mining and Reclamation Plan (MRP) states that there will be no postmining gravity discharge of mine water. Rule R645-301-731.520 requires mines to be designed to prevent gravity discharges. A Division Order (DO 08A) was issued on April 22, 2008 requiring Genwal to make requisite permit changes and update the MRP to include a plan for the discharge of post-reclamation mine water in accordance with R645-301-551, R645-301-731.521, and R645-301-751.

5. In October of 2008, iron concentrations in the mine-water discharge began to consistently exceed the limit of 1 mg/L authorized under the Utah Pollution Discharge Elimination System (UPDES) Permit UT0024368. A second Division Order (DO 09A) was issued November 24, 2009 and revised December 21, 2009 requiring Genwal to submit an application for a permit change to include a operating cost estimate for the ongoing and continual treatment of the mine water discharge based on the plans that were proposed at that time; and to post an amount of money for a treatment trust fund in an amount sufficient to generate an annuity equal to the estimated costs of water treatment.

6. The Division may only allow postmining gravity discharge of mine water if the water complies with the performance standards of the R645 rules and UPDES permit requirements. (R645-301-731.520)

7. The Division has modified the times for compliance with Division Orders DO08A and DO09A as information about the nature of the mine water discharges and potential treatment methods have been revised. To date, Genwal Resources, Inc. has failed to fully comply with either Division Order.

   The deadline for compliance with the requirements of DO08A was continued on July 2, 2008 until October 2, 2008 due in part to the need to also address the Crandall Canyon Mine disaster Memorial permit change. It was extended again until Dec. 1, 2008. On June 23, 2009 a final extension was given until August 1, 2010 for completion and approval of the revised MRP.

   The dates for compliance with the requirements of DO09A originally required Genwal to submit a permit change application within 30 days and to submit a bond to cover ongoing and continual treatment of water within 60 days. On December 22, 2009 the DO was revised and the dates were extended until March 1, 2010 to submit a plan and until March 18, 2010 to submit the bond.

8. On March 1, 2010 Genwal sent a response and technical evaluation concluding that they considered the mine discharge to be an operational problem that will not require long-term postmining treatment. Genwal committed to providing a design for a treatment facility by May 1, 2010 and to address the water discharge treatment and bonding as part of their 2013 permit renewal.

9. The Division responded that this was not an acceptable or agreeable solution.

10. On June 7, 2010, the Division completed a report titled Hydrologic Evaluation of the Crandall Canyon Mine Discharge (enclosed). The Evaluation thoroughly examined the discharge of water from the Crandall Canyon Mine workings and associated concentrations of iron. It also discussed the efforts made by the operator to treat the water to reduce the iron concentration to a level that is below the UPDES criterion. The Hydrologic Evaluation made four findings:

(a) Water is likely to continue to flow from the mine workings in perpetuity;
(b) The source of the elevated iron is most likely pyrite found in the coal and the surrounding strata as it becomes exposed to groundwater;
(c) The mine discharge water is high in sulfate and iron which is consistent with oxidation of pyrite and the rate of oxidation does not appear to be slowing; and
(d) Based on these findings there is a likelihood of a perpetual discharge of mine water containing elevated concentrations of iron, which will require ongoing treatment.

The Hydrologic Evaluation made the following recommendations:

(a) The Operator should collect additional information on the chemistry and flow of the mine water discharge. The additional information is needed to evaluate treatment options, provide information for postmining treatment system design, and to provide baseline data to evaluate changes in the discharge over time.

(b) The Operator should revise the Probable Hydrologic Consequences (PHC) determination for the Crandall Canyon Mine to reflect current conditions. The new PHC must address the impact to water quality and aquatic habitat and include water-monitoring recommendations. The Division must revise the Cumulative Hydrologic Impact assessment (CHIA) based on the new PHC and the information in the Hydrologic Evaluation report.

(c) The Operator should complete a comprehensive investigation and treatment study to evaluate the potential feasibility of treatment technologies and conduct treatment testing to assess the effectiveness and costs associated with treatment alternatives.

(d) The Operator should revise the MRP to accurately describe the "operational" treatment system and include a summary of the actual capital and operating costs of the "operational" treatment system.

11. Based on this Evaluation Report and further consideration of the facts and applicable regulations, the Division makes these additional Findings of Permit Deficiency:

(a) The bond for the Crandall Canyon Mine must be increased to cover long-term, and likely perpetual treatment of the mine-water discharge. The bond will consist of a trust fund or other funding instrument, to be established immediately, which will yield a yearly payment sufficient to cover mine-water treatment costs in perpetuity. The Division has estimated the yearly operating cost to be $325,000. The amount will be adjusted when more accurate operational and postmining water treatment costs are provided to the Division.

(b) The Division cannot allow operations to continue under the permit unless there is assurance that the operations will comply with certain necessary conditions of the permit, both during and after mining. The federal law and regulations, along with the Utah Statute and regulations require that there be no material damage to the hydrologic balance outside the permit area. This is a necessary condition of the permit, and there is no evidence that the polluted mine-water discharge will cease upon complete reclamation of the Crandall Canyon Mine, and thus adequate funding for perpetual treatment is a necessary condition of the permit.

Based on the findings of permit deficiency identified above, the Division now issues this Division Order. This Division Order supersedes the requirements of DO08A and DO09A.

ORDER

Genwal Resources, Inc. is hereby ordered to do the following:

I. Commencing immediately upon receipt of this Order, and continuing throughout the life of the permit, and until the Division deems it no longer necessary Genwal shall:

Conduct the following monitoring and collection of additional information on the chemistry and flow of the mine-water discharge. (R645-301-724.500; R645-300-145.100 and 145.200):

a. Measurement of the discharge rate from the sealed portals; either continuously (e.g., using a data logger) or at a minimum, daily.
b. Monthly whole water chemical analysis and field measurements of the ***untreated*** mine discharge. The analysis must include:
    i. Calcium (dissolved)
    ii. Potassium (dissolved)
    iii. Sodium (dissolved)
    iv. Magnesium (dissolved)
    v. Silica
    vi. Chloride
    vii. Hot acidity by Standard Method 2310B 4(a)
    viii. Aluminum (total and dissolved)
    ix. Iron (total and dissolved)
    x. Manganese (total and dissolved)
    xi. Sulfate
    xii. Alkalinity (total, carbonate, and bicarbonate)
    xiii. TDS
    xiv. Suspended solids

xv. Ferrous iron (field)
xvi. pH (field)
xvii. Dissolved oxygen (field)
xviii. Conductivity (field)
xix. Temperature (field)
xx. Flow (field)

II. By August 31, 2010

Amend the MRP to reflect the required additional water monitoring and data collection. The MRP must include a commitment to submit the mine-water discharge monitoring data to the Division monthly. Water chemistry and field measurement data will be submitted electronically using the Division's water monitoring database EDI system. Mine-water discharge rate data will be provided in a spreadsheet format.

III. By October 16, 2010

Provide a bond ***or*** establish a trust fund or other funding instrument acceptable to the Division that will yield a yearly payment sufficient to cover mine-water treatment costs in perpetuity. The Division has estimated the yearly operating cost for the "operational" treatment system to be $325,000. The bond or yearly payment amount will be adjusted when Genwal Resources, Inc. supplies more detailed cost information for the "operational" treatment system or based on the design, and cost estimate for a postmining (reclamation phase) treatment system.

Any proposed bond or trust fund amount will be subject to approval of the Division pursuant to R645-301-830. The Division will provide notice and opportunity for informal conference in accordance with R645-301-830.420.

IV. By October 31, 2010:

1. Amend the MRP to reflect the current operations, especially the "operational" treatment measures and facilities associated with the ongoing mine-water discharge, including all aspects of the treatment process with associated costs (capital, operations, maintenance) and as-built drawings. (R645-303-212)

2. Revise the Probable Hydrologic Consequences (PHC) determination in the MRP to reflect current conditions for the Crandall Canyon Mine. The new PHC must address the impact to water quantity and quality and aquatic habitat. It must also include water-monitoring recommendations, and describe how water-monitoring data will be used.

V. By March 31, 2011

1. Amend the MRP to reflect the recently updated R2P2 filed with the BLM. (R645-303-212)

2. Amend the MRP with feasible plans to address the mine-water discharge in perpetuity. (R645-303-212) This must include:
    a. A comprehensive investigation and treatment study to evaluate the potential feasibility of treatment technologies for postmining (reclamation phase) water treatment.

    b. Treatment testing to assess the efficacy and costs associated with treatment alternatives.

    c. Design of a postmining water treatment system based on the treatment studies

    d. Capital and operating costs for the postmining water treatment system.

    e. Updated reclamation bond calculations based on the new reclamation plan.

    A qualified water-treatment engineer or other appropriate professional scientist with experience in long-term ferruginous alkaline water treatment must be involved in crafting the postmining water treatment plan. (R645-301-130)

    The Division will not accept as sufficient any plan that has not been properly and thoroughly designed according to professional standards. Details regarding the requirements of the treatment study and testing are provided on page 27 of the enclosed Hydrologic Evaluation Report.

DO10A is issued pursuant to R645-303-212. Within thirty (30) days of your receipt of the order you may make a written appeal of the provisions therein to the Board of Oil, Gas and Mining, as provided for by Utah Administrative Rules R645-303-213 and R645-300-200.

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Hydrologic Evaluation of the Crandall Canyon Mine Discharge

June 7, 2010

Prepared By:
State of Utah
Department of Natural Resources
Division of Oil, Gas & Mining

UTAH DNR OIL, GAS & MINING

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Table 3. Sulfur Content in Genwal Coal, 2004 – 2007

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Table 5. Crandall Canyon Mine Water Discharge Chemistry, January 2008 – April 2010

Table 6. Crandall Canyon Mine Discharge Saturation States for Selected Mineral Species

Table 7. Sulfate Composition of Spring Waters from Different Water-Bearing Zones In and Adjacent to the Upper Drainages of Huntington and Cottonwood Creeks

Figures

Figure 1. Map Showing Crandall Canyon Mine Location and Other UtahAmerican Energy Inc (UEI) Coal Mine Permit Areas

Figure 2. Map Showing Crandall Canyon Mine and Joes Valley Fault

Figure 3. Plots Showing Selected Crandall Canyon Mine Water Discharge Monitoring Parameters, 1995 – Present

Figure 4. Recent Trends in Iron and Total Dissolved Solids Concentrations in Crandall Canyon Mine Water Discharge

Figure 5. Plots Showing Water Quality Data from Crandall Canyon Mine and Skyline Mine CS-14

Figure 6. Crandall Canyon Mine Water Treatment System Process Flow Diagram

Attachments

Attachment 1. Crandall Canyon Mine Development History

Attachment 2. September 20, 2007 Letter re: Temporary Cessation of Coal Mining and Reclamation Operations Genwal Mine 015/032

Attachment 3. March 30, 2010 Letter re: Minor Modification to Resource Recovery and Protection Plan (R2P2), Revised Mining Plans with Timing, North and South Crandall Mines, UtahAmerican Energy, Inc. (UEI)

Attachment 4. Geochemist's Workbench Input & Output Summary

Hydrologic Evaluation – Crandall Canyon Mine Discharge

1 Introduction

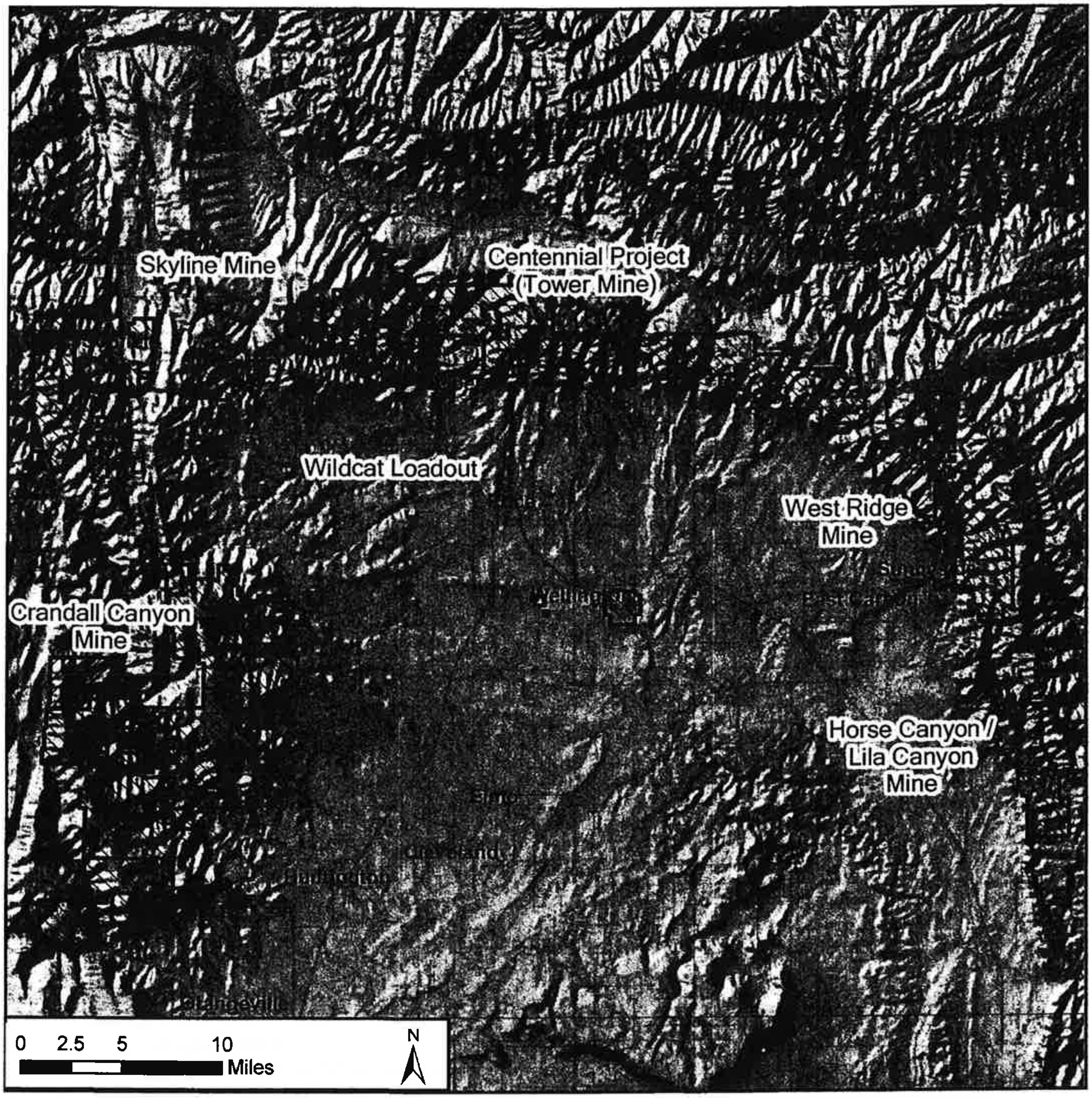
This report presents a hydrologic evaluation of the mine water discharge from the Crandall Canyon Mine. Mine water discharge is currently being treated to address elevated concentrations of iron in the discharge. The Operator has successfully implemented a water treatment approach which reduces iron concentrations to below their UPDES discharge criterion; however, to date the Operator has not posted additional bond to provide for perpetual treatment of the discharge, nor has the Operator evaluated alternative treatment options. The Operator has expressed that they believe the iron to be a temporary problem and that concentrations will decline over a relatively short timeframe (i.e., a few years) and has delayed posting additional bond. The Operator's position conflicts with the policy of the Office of Surface Mining (OSM) on acid/toxic mine drainage, which states that "[i]n the absence of definitive knowledge about the duration of postmining pollutional discharges, the financial assurance would have to provide for perpetual treatment" (OSM 1997).

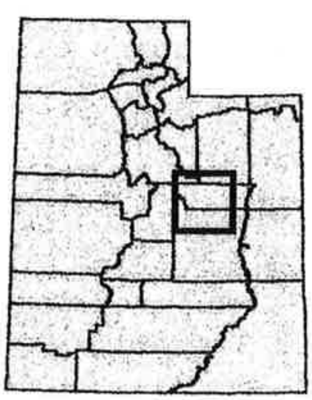
The Utah Division of Oil, Gas and Mining (the Division) has prepared this hydrologic evaluation to address the conditions at the Crandall Canyon Mine and the potential for perpetual discharge of mine water containing elevated concentrations of iron. Site water quality data used for this report were collected by the operator and submitted to the Division. Previous hydrologic investigations completed at the site and included in the Mining and Reclamation Plan are available through the Division's Public Information Center.

2 Background

The Crandall Canyon Mine is located in Huntington Canyon on the eastern edge of the Wasatch Plateau Coal Field approximately 16 miles west of Huntington, Utah in Emery County (Figure 1). The permit area encompasses over 5,000 acres within a combination of federal leases, state leases and fee land. The mine is located entirely within the Manti-LaSal National Forest with an associated 10 acres of disturbed land where surface operations were conducted in T16S R7E S7E.

The permit area is in mountainous terrain, with ground elevations ranging from approximately 7,800 feet above mean sea level (ft amsl) at the surface facilities to over 10,700 ft amsl a long East Mountain. Coal is accessed from portals on the north and south sides of Crandall Canyon, with portal elevations being approximately 7,900 ft amsl. Crandall Canyon creek is a perennial stream which discharges to Huntington Creek, a tributary of the Price River and a popular destination for anglers. The Utah Division of Water Rights currently has on file over 80 water right claims on Huntington Creek for irrigation, stock, domestic, municipal, industrial, power generation, and fish culture uses. A portion of flow from Huntington Creek is diverted to a municipal water treatment system near Huntington operated by the Castle Valley Special Services District. The high-value aquatic habitat and municipal water supply downstream of the Crandall Canyon mine outfall underscore the sensitivity of the environment to the iron and associated stream discoloration from the mine discharge and the use of chemicals for water treatment.





LEGEND

UtahAmerican Energy Inc (UEI) Permits

Other Coal Mine Permit Areas

Figure 1. Map Showing Crandall Canyon Mine Location and Other UtahAmerican Energy Inc (UEI) Coal Mine Permit Areas

Huntington Creek and its tributaries (including Crandall Creek) are designated with the following use classifications under the Standards of Quality for Waters of the State, UAC Rule R317-2:

Class 1C - Protected for domestic purposes with prior treatment by treatment processes as required by the Utah Division of Drinking Water

Class 2B - Protected for infrequent primary contact recreation. Also protected for secondary contact recreation where there is a low likelihood of ingestion of water or a low degree of bodily contact with the water. Examples include, but are not limited to, wading, hunting, and fishing.

Class 3A - Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.

Class 4 - Protected for agricultural uses including irrigation of crops and stock watering.

2.1 Mine History

Historically, mining was conducted in the area from November of 1939 to September of 1955 utilizing the room and pillar method. Genwal Coal Company resumed mining in 1983 with production ranging from 100,000 to 230,000 tons per year. In 1989, the mine was purchased by NEICO, and in 1990 Intermountain Power Agency (IPA) purchased a 50% interest. A continuous haulage system was incorporated into the room and pillar mining method in 1991, which allowed an increase in production ranging from 1,000,000 to 1,500,000 tons per year. In March 1995, the mine was transferred to Genwal Resources, Inc. (which is owned by IPA and Andalex Resources, Inc.). A longwall was installed that same year which nearly doubled the capacity of the mine. An additional longwall was purchased in 1997 to increase production from 2,500,000 tons to 3,500,000 tons per year (http://ogm.utah.gov/coal/mines/C015032.htm). A figure showing the mine development history is provided as Attachment 1.

In August of 2006, Murray Energy Corporation purchased all of the shares of the common stock of Andalex and its subsidiaries. Operations of the Andalex mining operations are conducted by UtahAmerican Energy Inc. (UEI), the Utah subsidiary of parent Murray Energy Corporation. To this day, UtahAmerican Energy continues to operate the Crandall Canyon Project as well as the West Ridge Project, Tower Division (Centennial Mine) and the Wildcat Loadout (http://ogm.utah.gov/coal/mines/C015032.htm). The locations of UEI mining operations are shown on Figure 1.

On August 6th, 2007, a major collapse occurred in the Crandall Canyon coal mine. The collapse resulted in the loss of six miners. Ten days later, a smaller collapse in the mine resulted in the deaths of three rescue workers and injured six others (Stricklin, 2007). University of Utah seismologists reported that a local magnitude (M_L) 3.9 seismic event occurred at approximately the same time and place as the Crandall Canyon Mine Collapse (Pechmann et al., 2008). The University of Utah seismologists concluded that the seismological evidence indicated that most of the seismic wave energy was produced by the mine collapse and not by a naturally occurring earthquake. The University of Utah seismologists utilized a "high-quality" data set in analyzing the Crandall Canyon seismic event. The data was obtained from surrounding stations of the University of Utah regional seismic network, a 5-station temporary network that was deployed in the mine area following the August 6th collapse, the National Science Foundation Earthscope Transportable Array as well as other networks (Pechmann et al, 2008). The Mine Safety and Health Administration (MSHA) found that the August 6th, 2007 collapse was the result of an inadequate mine design and cited, among other factors, a flawed engineering analysis and unauthorized mining practices by the Operator who was mining coal in areas with unsafe conditions (MSHA 2008).

The August 6th, 2007 collapse occurred in the west mains section of the mine. This portion of the mine works was developed in the Hiawatha coal seam at depths of approximately 1,000-2,200 feet below the surface (Hucka, 1991; MSHA, 2008). Based on the information gathered by Pechmann et al. (2008), the minimum collapsed area of the underground workings is approximately 40 acres. The approximate location of the collapse is shown on Figure 2.

In a letter dated September 20th, 2007, the Permittee notified the Division that the Crandall Canyon Mine was entering into a period of temporary cessation of coal mining and reclamation operations (Attachment 2). All equipment that could be accessed safely was removed from both the North and South Crandall Canyon mines as part of the cessation process, and temporary concrete block walls (as opposed to permanent closure seals requiring BLM approval) were installed in all mine openings. Environmental monitoring is conducted as approved under the Mining and Reclamation Plan (MRP) and will continue during the temporary cessation period. At present, the mine remains idle.

However, on March 20th, 2010, the Bureau of Land Management (BLM) approved a modification to the Resource Recovery and Protection Plan (R2P2) for the Crandall Canyon Mine (Attachment 3). According to the modification, a restart of mining operations will begin in 2012. The 2012 mining is to occur within the south lease area (Federal Lease UTU-78953) and continue in the southern lease area through 2018. Additionally, the revised R2P2 calls for mining operations to resume within the north federal lease (Federal Lease UTU-68082) in the year 2019 and continue through 2022.

2.2 Mine Discharge Violations

In January 2008 the mine began discharging by gravity flow and has been discharging continuously since. The mine water discharge contained elevated concentrations of iron which resulted in precipitation of iron in Crandall Creek and orange-staining of the creek channel. The discharge of iron-containing mine water to Crandall Creek resulted in the Permittee being issued several violations from both the Utah Division of Water Quality (DWQ) and the Division. Non-compliant conditions have been cited by DWQ and the Division under the regulatory framework outlined by the Utah Pollutant Discharge Elimination System (UPDES) and the State of Utah R645-Coal Mining Rules, respectively, as follow:

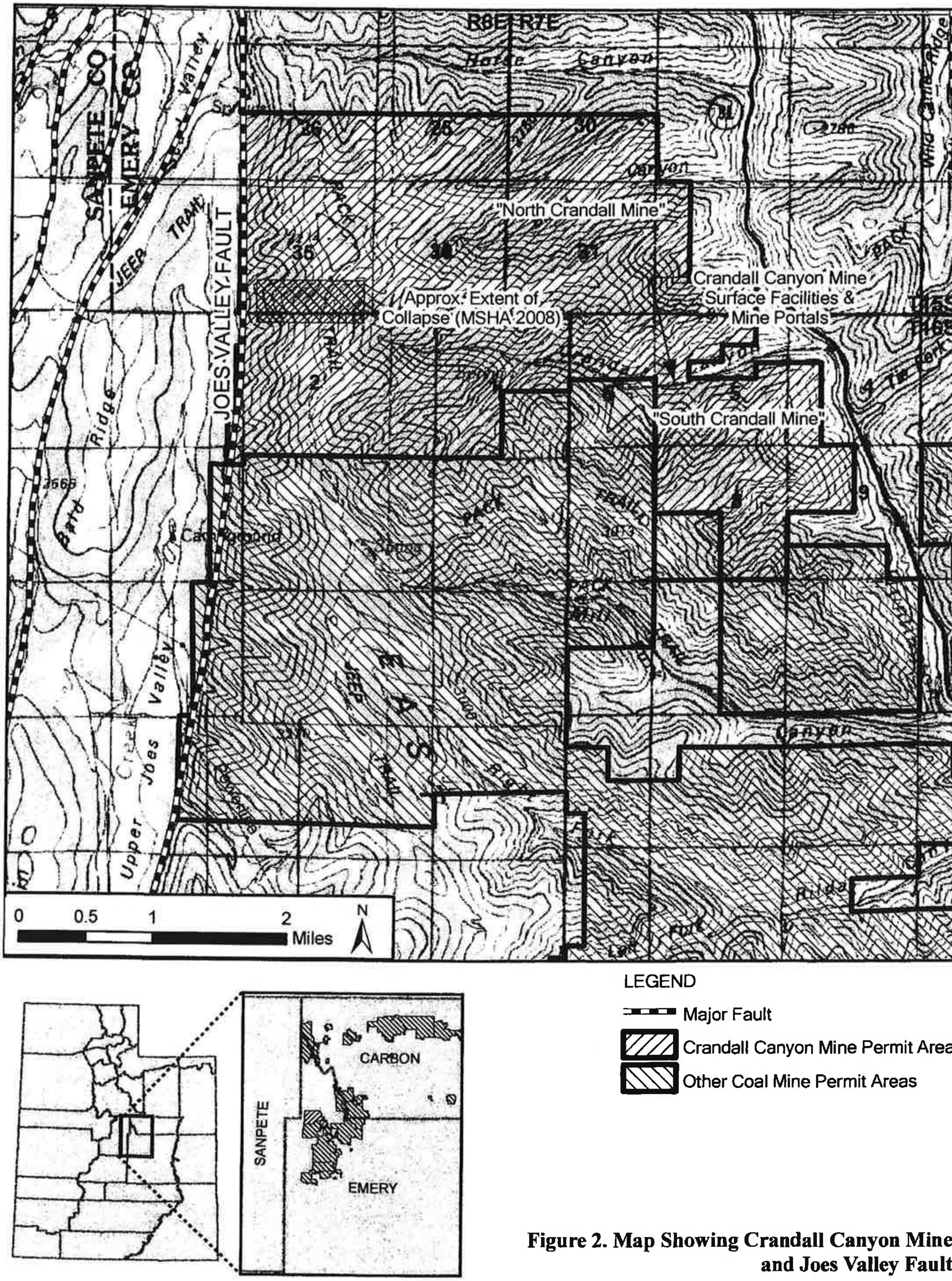


Figure 2. Map Showing Crandall Canyon Mine and Joes Valley Fault

DWQ Violation History

- DWQ issued its first Notice of Violation (NOV) to the Permittee on February 26th, 2009 (Docket No. I09-02). The NOV was issued due to effluent samples obtained from Outfall 002 (mine-water discharge) exceeding compliance levels for total iron (T-Fe).
- DWQ issued a second NOV to the Permittee on August 10th, 2009 for violating the Narrative Standard for water quality for Crandall Creek (Docket No. I09-18). At the time of the second DWQ NOV issuance, the mine-water discharge continued to produce T-Fe concentrations greater than that allowed by the Permittee's UPDES permit (#UT0024368). In addition, the continual discharge of non-compliant iron concentrations from Outfall 002 had begun to stain the substrate of the Crandall Creek channel with a rust-colored appearance.
- On February 10th, 2010, the Permittee and DWQ finalized a settlement agreement for the two NOV's. The settlement agreement required a 30-day public notice, full payment of the penalty amount within 30 days and a requirement for the Permittee to fund a Supplemental Environmental Project no later than one year from the effective date of the settlement. On March 8th, 2010, DWQ had received full payment of the penalty amount resulting in the closure of Docket No. I09-02. Final closure of Docket No. I09-18 will occur upon the completion of the Supplemental Environmental Project.

DOGM Violation History

- The Division issued two NOV's at the onset of the gravity discharge of mine-water from the temporary seals of the north portals. Citations #10016 and #10017 were issued on January 14th, 2008 for gravity mine water flow from the north portals of the Crandall Canyon Mine and for said discharge entering the disturbed drainage system. The two NOV's were terminated on January 24th, 2008 once the Permittee was successful in re-routing the mine-water discharge into the authorized conveyance structure and discharge point.
- The Division issued NOV Citation #10043 on August 10th, 2009 for failing to minimize disturbance to the hydrologic balance and diminution or degradation of the quality of surface water. As with the second DWQ NOV discussed previously, Citation #10043 was issued due to the orange staining that was occurring within the Crandall Creek channel. On January 1st, 2010, NOV Citation #10043 was terminated upon the Division's conditional approval of the operational water treatment system.

The Division has been working with the Permittee since April of 2008 in developing a long-term water treatment plan to be utilized upon final reclamation of the site. To that end, the Division has issued the Permittee a Division Order to address mine water treatment. As this process has developed, additional information, concerns and site considerations have been identified that warranted revisions to the Division Orders.

3 Hydrologic Evaluation

The hydrologic evaluation included in the following sections presents information relative to the mine water discharge rate and chemistry. This evaluation is based primarily on data collected by the operator during operations and following the 2007 mine collapse. Relevant information on regional geology and hydrology is also presented.

3.1 Crandall Canyon Mine Water Discharge

Discharges from the Mine were intermittent prior to 1996. As mining progressed to the west towards the Joes Valley fault, more water was encountered by the workings, and beginning in 1996 the mine began continuously discharging water. Upon reviewing Division records and information submitted by the Permittee, it's unclear as to the precise timing/date when significant inflows of water were encountered. However, based upon information supplied by the Permittee in the 1996 and 1997 annual reports, first and secondary mining activity was occurring within T15S R6E, Sections 26 and 35 located adjacent to the Joe's Valley Fault system. Water encountered during mining operations was pumped to the portals and discharged to Crandall Creek under UPDES Permit No. UTU0024368. Discharges to Crandall Creek were within the limitations established by the permit with rare exceptions. For example, prior to 2008 the only sample containing iron at greater than 1 mg/L was on July 26, 2004, when iron was 1.08 mg/L.

Following the mine collapse in August 2007, the pumps were removed from the mine and discharge ceased temporarily. From September 2007 through December 2007 water pooled within the mine, flooding the underground workings. In January 2008 the mine began discharging by gravity flow and has been discharging continuously since. The temporary seals placed in the portals following the collapse required modification for the mine water discharge. Iron concentrations in the mine water discharge occasionally exceeded 1 mg/L from January to November 2008; and have been greater than 1 mg/L continuously since December 2008. In response to NOV Citation #10043 issued August 10, 2009, a water treatment system was constructed at the site in December 2009 to treat the mine water discharge.

3.1.1 Discharge Characteristics

A summary of the available flow, temperature, and dissolved oxygen data for the mine water discharge is provided in Table 1 and plotted in Figure 3. Data are separated into the period prior to mine collapse (1996 – 2007) and following the collapse (2008 – present). The data in Table 1 indicate that discharge conditions were more variable prior to the mine collapse and flooding, as evident by a comparison of the ranges of values reported. During the operational period of the mine, however, the mine water discharge was controlled by pumping, therefore the variability in discharge rates is likely influenced by the operation of pumps and may not reflect variability in the amount of groundwater discharging into the mine. The discharge has averaged 490 gpm with and average temperature of 11.7 degrees C and average dissolved oxygen concentration of 8.7 mg/L.

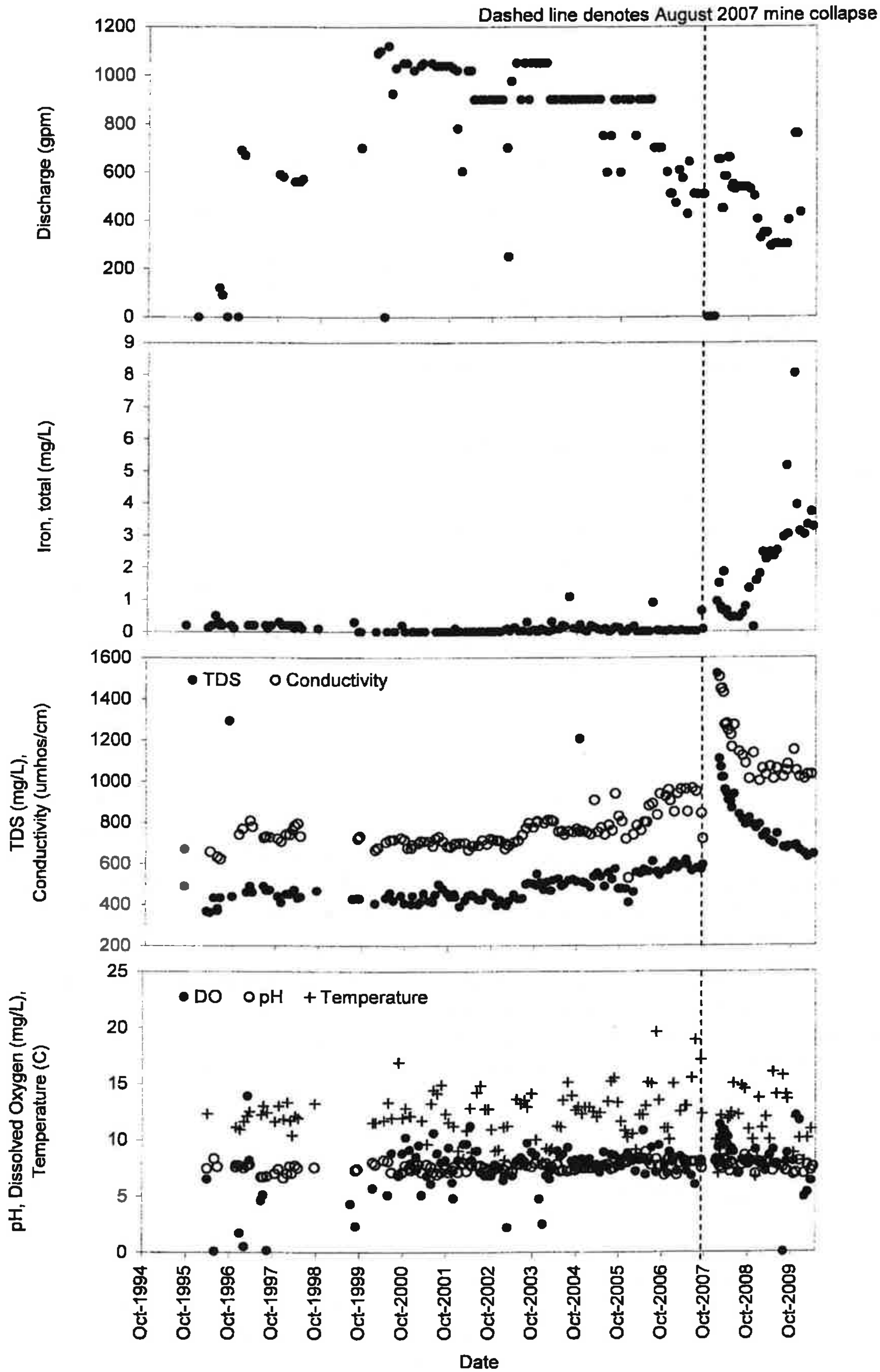


Figure 3. Plots Showing Selected Crandall Canyon Mine Water Discharge Monitoring Parameters, 1995 – Present

Table 1. Mine Water Discharge Rate Summary, 1996 – 2009

Period	Discharge (gpm) No. Measure-ments	Discharge (gpm) Average (Range)	Temperature (degrees C) No. Measure-ments	Temperature (degrees C) Average (Range)	Dissolved Oxygen (mg/L) No. Measure-ments	Dissolved Oxygen (mg/L) Average (Range)
Pumping 1996 – 2007	102	804 (0 – 1120)	108	12.1 (7.1 – 19.6)	102	7.4 (0.1 – 13.9)
Gravity Discharge 2008 – 2009	29	490 (292 – 757)	29	11.7 (6.7 – 16.0)	29	8.7 (0 – 12.1)

Source: Monitoring data submitted by the Operator to the Division

The flow data shown in Figure 3 do not illustrate a trend or seasonal variability in flow rates from the mine. The operator has reported that since the 2007 collapse, mine flow rates fluctuate as a function of barometric pressure and/or air temperature changes. The absence of a continuous monitoring record of mine discharge rate to date prevent the validation of these observations. An electronic flow meter (Grayline AVFM-100 area-velocity flow meter) capable of supporting a data logger and telemetry was installed by the operator during 1st quarter 2010. It is hoped that a continuous or daily flow record will be obtained from the new flow meter, which will improve the understanding of flow characteristics and which may enable correlation between flow and weather conditions.

3.1.2 Potential Water Sources

The source of the mine water has not been confirmed. Potential sources of the mine water include Joes Valley fault, local recharge of precipitation, regional / perched aquifers or other sources. Prior to the mine collapse, the largest inflows to the mine were reportedly from sandstone channels intercepted near the Joes Valley fault. The interaction between Crandall Canyon Mine and the Joes Valley fault groundwater system was investigated during the 1990s, as described in Section 3.2.4.

Detailed discharge studies, geochemical characterization (including isotopic and dissolved gas composition), or other investigations of the potential source of the mine discharge have not been performed, although the most likely source of mine water appears to be the Joes Valley fault system. Based on the available data, the source of the mine water appears to be capable of supporting a continuous discharge, and the source does not appear to be diminishing over time.

3.2 Crandall Canyon Mine Water Chemistry

This section provides a description of the chemistry of the mine water discharge at Crandall Canyon Mine as relating to the occurrence and trend in iron concentrations. Data relevant to the source of the iron contamination are presented, and water quality monitoring data are presented and discussed. A literature review relevant to mine discharges in the Wasatch Plateau region and long-term trends in iron concentrations from other coal mining regions is provided, along with a summary of previous geochemical investigations completed for the Crandall Canyon Mine.

3.2.1 Potential Iron Sources

The most likely source of the iron in the mine water is pyrite (FeS_2) oxidation. Pyrite oxidation is widely accepted as the principal cause of ferruginous (iron-containing) drainage from coal mines. Pyrite oxidation generates sulfate, acidity, and dissolved iron, as described by the following reaction:

$$FeS_2 + 7/2O_2 + H_2O = Fe^{2+} + 2SO_4^{2-} + 2H^+$$

The reaction shows the product of pyrite oxidation is a solution containing ferrous iron and sulfate, which is consistent with the water quality discharging from the Crandall Canyon Mine. The acidity generated from pyrite oxidation is consumed by dissolution of carbonate minerals, which are prevalent in the Wasatch Plateau.

The average sulfur and pyrite composition of coal from the Wasatch Plateau region and from the Hiawatha NW Quadrangle sub-region (which includes the Crandall Canyon Mine) are shown in Table 2. The average sulfur content reported for the Hiawatha NW Quadrangle is consistent with the coal sulfur content of coal from the Crandall Canyon Mine as reported to the Utah Geologic Survey by the Operator for years 2004 to 2007 (Table 3). Coal in the Crandall Canyon Mine area may therefore be characterized as containing about 0.5 percent total sulfur and about 0.08 percent pyritic sulfur.

Pyrite is also present in the strata above and below the Hiawatha and Blind Canyon coal seams mined at the Crandall Canyon Mine. The Hiawatha and Blind Canyon coal seams are both within the Blackhawk formation, with the Blind Canyon seam lying 55 to 100 feet above the Hiawatha. Only the Hiawatha seam was mined in the North Crandall leases due to the low thickness (generally less than three foot) of the Blind Canyon seam (MSHA 2008). Table 4 presents a summary of the chemical composition of the strata above and below the Hiawatha and Blind Canyon coal seams, as reported by the Operator in the MRP. The pyrite composition is greatest (0.09 percent) in the stratum overlying the Blind Canyon coal seam. The August 2007 mine collapse occurred as miners were removing coal from pillars in the Hiawatha coal seam.

The available data demonstrate that pyrite is present within the coal and the strata above and below the coal seams at the Crandall Canyon Mine. The total amount of pyrite present and the amount accessible to oxygenated groundwater have not been estimated; indeed this calculation is not feasible given the unknown extent of the mine collapse. Coal reserves at the Crandall Canyon Mine are believed to be sufficient to re-initiate mining in the future. The Operator has not collected any information or demonstrated that the pyrite available for oxidation within the collapsed Crandall Canyon Mine will be consumed in the foreseeable future. Absent such a demonstration, it is assumed that pyrite oxidation and the associated liberation of iron will continue perpetually.

Table 2. Regional Sulfur Content in Coal from the Wasatch Plateau and the Hiawatha NW Quadrangle

Area	No. Samples	Average Percent Content (Range) Total Sulfur	Sulfate	Pyritic	Organic	Source
Wasatch Plateau	722	0.60 (0.23 – 1.60)				1
	37	0.52 (0.36 – 0.89)	0.01 (0.00 – 0.03)	0.10 (0.01 – 0.20)	0.41 (0.18 – 0.69)	2
Hiawatha NW Quadrangle	40	0.55 (0.23 – 0.80)				1
	6	0.52 (0.38 – 0.77)	0.01 (0.01 – 0.02)	0.08 (0.05 – 0.11)	0.42 (0.32 – 0.66)	2

Sources:
1. Doelling 1972
2. U.S. Bureau of Mines (Walker and Hartner, 1966)

Table 3. Sulfur Content in Genwal Coal, 2004 – 2007

Year	Mine	Seam(s)	Heat Content	Sulfur	Ash	Moisture
2004	Crandall Canyon and South CC	Hiawatha	12,300	0.6%	9.0%	7.5%
2005	Crandall Canyon and South CC	Hiawatha/ Blind Canyon	11,305	0.6%	14.2%	8.6%
2006	Crandall Canyon and South CC.	Hiawatha/ Blind Canyon	11,655	0.6%	11.7%	8.8%
2007	Crandall Canyon	Hiawatha	12,014	0.4%	9.0%	5.0%

Source: UGS http://geology.utah.gov/emp/energydata/coaldata.htm

Table 4. Pyrite Content in Strata Above and Below Coal Seams

Coal Seam	Stratum	Pyrite	Paste pH	Alkalinity
Blind Canyon	Above	0.09%	7.25	87.4 mg/L
	Below	0.07%	3.90	0 mg/L
Hiawatha	Above	0.03%	7.6	63.3 mg/L
	Below	0.06%	3.95	4.0 mg/L

Source: Crandall Canyon Mine MRP Section 6.24.32

3.2.2 Literature Review

Literature on the occurrence and mechanisms of acid and toxic mine drainage is widely available; however, the majority of the available literature addresses acid mine drainage. Coal fields in the western U.S. generally do not have net acidic discharges due to buffering by carbonate minerals. The mine water discharge at Crandall Canyon Mine is categorized as an alkaline mine drainage due to its pH of greater than 6.0 and its alkalinity content (greater than zero).

The long-term effects of underground coal mining on groundwater in Utah have not been well documented; however, some information is available. In a report describing the hydrology and potential effects of coal mining at the Castle Valley coal-lease tract in the Wasatch Plateau, which is located approximately 5 miles northeast of Crandall Canyon, Seiler and Baskin (1988) reported that water quality changes soon after a mine is abandoned, and that groundwater from an area where roof collapse has occurred is more acidic, more mineralized, and contains a greater concentration of sulfate compared to water encountered in the active portion of a mine. The authors also identified that water quality from a recently abandoned portion of the King mine resembles that of water discharging from a nearby mine which had been abandoned for more than 30 years, and concluded that "[t]hus, water quality may not return to its original state for a long time after mining has caused the quality to change".

Mayo et al. (2000) described chemical evolution of coal mine drainage at the SUFCO Mine, located in the Wasatch Plateau coal field approximately 40 miles south of Crandall Canyon. Geochemical modeling results indicate that flooding mine openings with oxygen is a critical element for the chemical evolution of mine drainage, and that most sulfate results from pyrite oxidation. Mine water chemistry is greatly influenced by the water-rock ratio, where a decrease in the water-rock ratio increases the groundwater-mineral contact time and promotes kinetically-limited pyrite oxidation. The declining discharge rate from older mined areas has resulted in increased TDS in the mine water over a nine-year monitoring period (Mayo et al. 2000).

3.2.3 Available Crandall Canyon Mine Discharge Chemistry Data

The chemistry of the mine water discharge from the Crandall Canyon Mine has been monitored over the life of the mine by the Operator per the monitoring program described in the MRP and as a condition of their UPDES permit. Required monitoring parameters under the permit include discharge rate, pH, total dissolved solids (TDS), total suspended solids (TSS), total iron, dissolved oxygen, sanitary waste, whole effluent toxicity and oil & grease. UPDES monitoring includes collection of samples for laboratory analyses and measurement of field parameters (pH, temperature, conductivity and dissolved oxygen) are also monitored. Plots showing total iron, TDS, conductivity, pH, dissolved oxygen and temperature from 1995 to present are shown in Figure 3. Water monitoring data for the mine discharge from January 2008 to April 2010 are provided in Table 5. Recent trends in total iron and TDS concentrations are shown in Figure 4.

Table 5. Mine Water Discharge Chemistry, January 2008 - April 2010

Parameter		Units	1/10/2008	1/21/2008	1/28/2008	2/4/2008	2/11/2008	2/18/2008	3/3/2008	3/17/2008	4/1/2008	4/15/2008	5/5/2008	5/14/2008	6/1/2008
Discharge		gpm	653	--	653	--	448	448	582	582	660	660	535	549	528
pH			8.12	--	7.9	--	7.6	7.92	7.4	8.22	8.09	7.71	7.19	7.98	7.77
Dissolved Oxygen		mg/L	8.3	--	9.3	--	11.3	10.1	10.6	10.8	10.4	10.2	8.9	9.2	8.9
Conductivity		uS	0	--	1507	--	1446	1448	1429	1272	1279	1248	1225	1165	1272
Temperature		C	10	--	7	--	8.5	12.1	10.8	9.5	9.7	11.8	12	12.4	15
Calcium	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Magnesium	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Total	mg/L	0.937	2.204	1.494	0.815	0.765	0.668	1.846	0.626	0.653	0.491	0.433	0.457	0.448
	Dissolved	mg/L	--	0.161	0.034	0.111	0.036	0.021	0.01	0.02	0.027	0.019	<0.010	0.01	--
	Ferrous	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Aluminum	Total	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dissolved	mg/L	--		0.06	0.09	0.05	0.17	0.17	0.14	0.14	0.14	0.15	0.16	--
Manganese	Total	mg/L	--	0.138	0.121	0.107	0.109	0.107	0.101	0.096	--	--	--	--	--
	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Dissolved	mg/L	--	0.19	0.19	0.18	0.17	0.17	0.17	0.17	--	--	--	--	--
Nickel	Dissolved	mg/L	--	0.201	0.155	0.128	0.122	0.118	0.101	0.092	0.086	0.081	0.068	0.067	--
Selenium	Dissolved	mg/L	--	<0.01	<0.01	--	--	--	--	--	--	--	--	--	--
Zinc	Dissolved	mg/L	--	0.34	0.282	0.242	0.219	0.227	0.188	0.172	0.153	0.127	0.089	0.074	--
Sulfate	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloride	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Silica	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity	Bicarbonate	mg/L CaCO3	--	--	--	--	--	--	--	--	--	--	--	--	--
	Carbonate	mg/L CaCO3	--	--	--	--	--	--	--	--	--	--	--	--	--
	Total	mg/L CaCO3	--	--	--	--	--	--	--	--	--	--	--	--	--
Hot Acidity		mg/L CaCO3	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Dissolved Solids		mg/L	1523	1218	1108	1025	1068	1018	1019	957	941	907	899	868	936
Total Suspended Solids		mg/L	6	--	12	<4	<4	<4	35	4	4	4	<4	<4	4

Table 5 (continued). Mine Water Discharge Chemistry, January 2008 - April 2010

Parameter		Units	7/16/2008	8/8/2008	9/9/2008	10/10/2008	11/15/2008	12/9/2008	1/7/2009	2/3/2009	3/4/2009	4/6/2009	5/6/2009	6/3/2009	7/29/2009
Discharge		gpm	538	--	538	528	500	403	326	347	347	292	300	300	300
pH			7.04	--	8.6	8.2	8.6	6.95	7.99	7.78	8.01	7.9	7.22	7.78	7.55
Dissolved Oxygen		mg/L	7.1	--	8	7.8	8.09	9.1	8.1	7.9	7.2	8.6	9.1	7.79	<0.0
Conductivity		uS	1142	--	1087	1010	1135	0	1000	1060	1030	1070	1010	1060	1020
Temperature		C	12.2	--	14.5	10.9	10	6.7	13.7	11	12	10	16	14.02	15.7
Calcium	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Magnesium	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Total	mg/L	0.434	0.546	0.775	1.335	0.141	1.569	1.783	2.454	2.23	2.455	2.331	2.501	2.924
	Dissolved	mg/L	--	--	--	--	--	--	--	0.256	0.51	0.486	<0.010	0.748	0.849
	Ferrous	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Aluminum	Total	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dissolved	mg/L	--	--	--	--	--	--	--	0.14	--	0.12	--	--	--
Manganese	Total	mg/L	--	--	--	--	--	--	--	0.173	--	0.162	--	--	--
	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Dissolved	mg/L	--	--	--	--	--	--	--	0.16	--	0.16	--	--	--
Nickel	Dissolved	mg/L	--	--	--	--	--	--	--	0.033	--	0.032	--	--	--
Selenium	Dissolved	mg/L	--	--	--	--	--	--	--	<0.01	--	<0.01	--	--	--
Zinc	Dissolved	mg/L	--	--	--	--	--	--	--	0.011	--	0.015	--	--	--
Sulfate	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloride	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Silica	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity	Bicarbonate	mg/L CaCO3	--	--	--	--	--	--	--	--	--	--	--	--	--
	Carbonate	mg/L CaCO3	--	--	--	--	--	--	--	--	--	--	--	--	--
	Total	mg/L CaCO3	--	--	--	--	--	--	--	--	--	--	--	--	--
Hot Acidity		mg/L CaCO3	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Dissolved Solids		mg/L	837	813	789	819	786	772	789	730	747	707	696	743	677
Total Suspended Solids		mg/L	<4	<4	<4	5	<4	<4	4	<4	6	5	<4	9	7

Table 5 (continued). Mine Water Discharge Chemistry, January 2008 - April 2010

Parameter		Units	8/24/2009	9/3/2009	10/28/2009	11/18/2009	12/16/2009	1/28/2010	2/23/2010	3/26/2010	3/30/2010	4/12/2010	4/21/2010
Discharge		gpm	300	400	757	757	431	--	393	481	587	--	568
pH			7.23	7.23	6.92	7.04	8.12	6.98	7.76	--	--	7.55	6.91
Dissolved Oxygen		mg/L	8.03	8.8	8.07	12.1	11.68	4.89	5.3	--	--	--	6.53
Conductivity		uS	1050	1080	1150	1050	1020	1010	1030	--	--	--	1000
Temperature		C	14	13.6	8.8	11.9	10.1	8.1	10.1	--	--	--	10.2
Calcium	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	99.88	--
Magnesium	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	55.52	--
Sodium	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	34.34	--
Potassium	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	8.43	--
Iron	Total	mg/L	5.151	3.012	8.03	3.927	3.1	3.0	3.3	3.709	--	3.245	4.268
	Dissolved	mg/L	0.654	0.885	--	--	--	0.9	1.3	1.531	--	1.034	1.11
	Ferrous	mg/L	--	--	--	--	--	< 0.1 (Lab)	0.77 (Lab)	--	1.2	1.23	1.23
Aluminum	Total	mg/L	--	--	--	--	--	< 0.1	< 0.1	0.13	--	0.1	<0.02
	Dissolved	mg/L	--	0.1	--	--	--	< 0.1	< 0.1	0.11	--	<0.02	<0.02
Manganese	Total	mg/L	--	0.143	--	--	--	0.14	0.13	0.13	--	0.128	0.114
	Dissolved	mg/L	--	--	--	--	--	0.14	0.13	0.13	--	0.122	0.124
Boron	Dissolved	mg/L	--	0.15	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	mg/L	--	0.024	--	--	--	--	--	--	--	--	--
Selenium	Dissolved	mg/L	--	<0.01	--	--	--	--	--	--	--	--	--
Zinc	Dissolved	mg/L	--	0.014	--	--	--	--	--	--	--	--	--
Sulfate	Dissolved	mg/L	--	--	--	--	--	159	170	174	--	183	182.2
Chloride	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	10.76	10.76
Silica	Dissolved	mg/L	--	--	--	--	--	--	--	--	--	7.6	--
Alkalinity	Bicarbonate	mg/L CaCO3	--	--	--	--	--	381	379	374	--	380	380
	Carbonate	mg/L CaCO3	--	--	--	--	--	<10	<10	<10	--	<10	<10
	Total	mg/L CaCO3	--	--	--	--	--	381	379	374	--	380	380
Hot Acidity		mg/L CaCO3	--	--	--	--	--	--	--	--	--	-350	--
Total Dissolved Solids		mg/L	673	680	683	687	664	648	631	--	--	643	--
Total Suspended Solids		mg/L	6	6	9	7	5	7	6	--	--	7	--

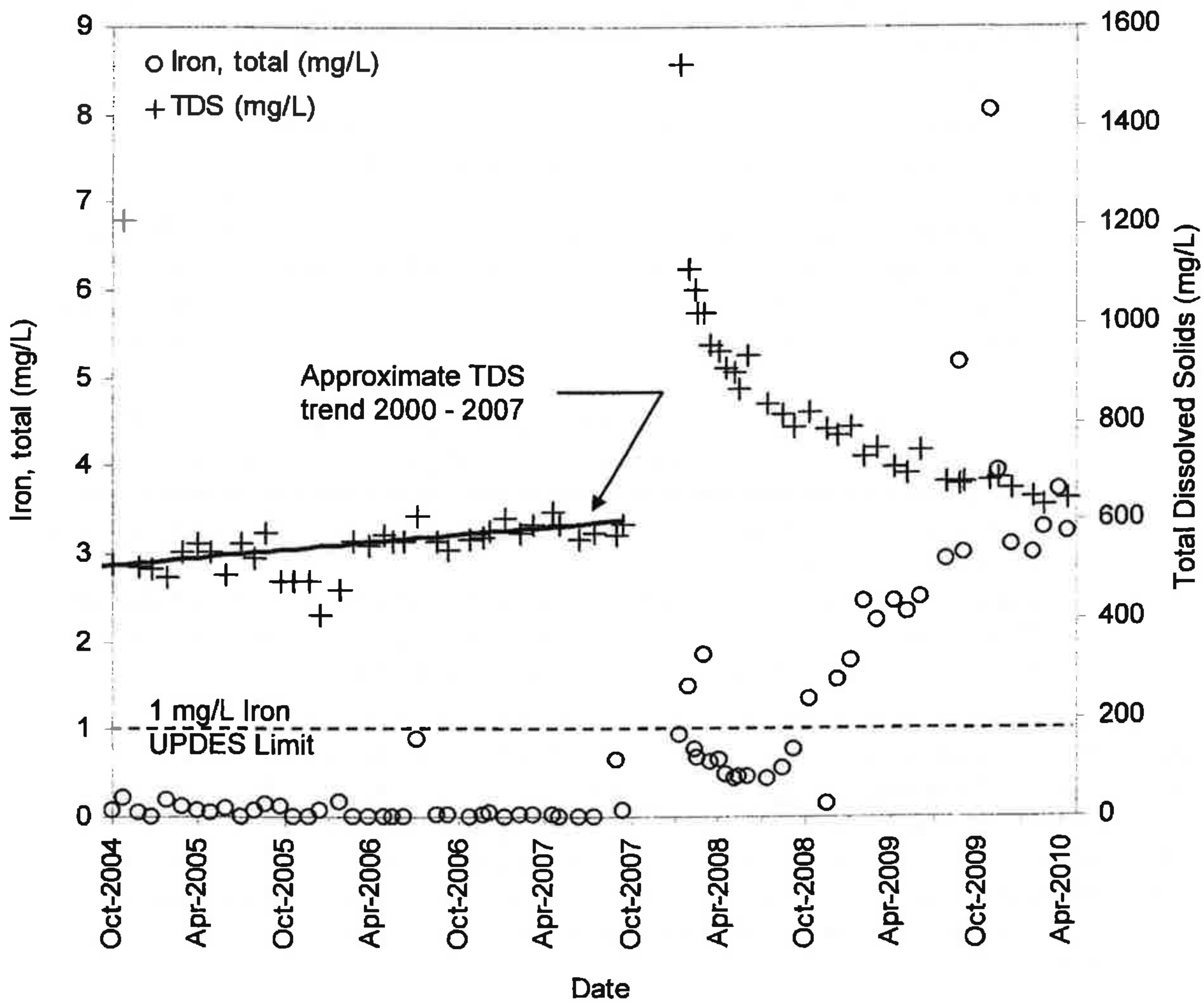


Figure 4. Recent Trends in Iron and Total Dissolved Solids Concentrations in Discharge from the Crandall Canyon Mine

A review of the plots of mine discharge monitoring data before and after the August 2007 mine collapse reveals three patterns:

1. Dissolved oxygen, pH and temperature show no discernable change prior to and following the collapse (Figure 3). Average values of dissolved oxygen, pH, and temperature in the mine discharge are 7.7 mg/L, 7.6 standard units, and 11.9 degrees C, respectively. The mine water has remained circum-neutral over the period of discharge, and no decrease in pH was recorded following the mine collapse.
2. Conductivity and TDS show a large spike after the collapse followed by a decline. Prior to the collapse, an increasing trend was evident for conductivity and TDS, as shown in Figures 3 and 4. The initial spikes in TDS and conductivity are presumably due to the flushing of readily soluble salts as the mine workings and rubble zones became flooded after the collapse and cessation of pumping at the mine. TDS and conductivity values declined as the solutes were flushed from the mine; however, values remain elevated above conditions prior to the mine collapse.
3. After the 2007 collapse total iron shows an initial, minor spike which declines and then increases (Figure 4). Prior to the mine collapse, total iron concentrations were generally non-detected or well below the UPDES discharge limitation of 1 mg/L. Samples of the mine water discharge collected from January through early March 2008 contained iron at concentrations near or greater than 1 mg/L (Table 5). Iron concentrations declined from mid-March 2008 through mid-July 2008, and then began increasing. Recent monitoring results show the mine water iron concentration to be approximately 3 to 4 mg/L (Table 5).

At the request of the Division, the Operator collected a sample of the mine discharge on April 12, 2010 for a whole-water chemical analysis. Results of this analysis are shown in Table 5. The analytical results were evaluated using AqQA and Geochemist's Workbench software. The calculated cation-anion balance for the analysis (0.94 percent) indicates that the analysis is of good quality. The mine water is of a calcium-bicarbonate type, and is supersaturated with calcium carbonate. Mineral saturation states calculated using Geochemist's Workbench are summarized in Table 6. Input and output information for the Geochemist's Workbench analysis is provided in Attachment 4.

Table 6. Crandall Canyon Mine Discharge Saturation States for Selected Mineral Species

Mineral	Saturation State (log Q/K)
Dolomite $CaMg(CO_3)_2$	1.95
Calcite $CaCO_3$	0.570
Aragonite $CaCO_3$	0.403
Siderite $FeCO_3$	0.273
Magnesite $MgCO_3$	-0.345
Silica (amorphous) SiO_2	-0.368
Gypsum $CaSO_4{\cdot}2H_2O$	-1.50
Anhydrite $CaSO_4$	-1.82
Pyrite FeS_2	$\ll$ -3

Note: A saturation state (log Q/K) of zero indicates saturation; a value greater than zero indicate super-saturation and a value less than zero indicates under-saturation.

The saturation states shown in Table 6 indicate that the mine water chemistry is principally controlled by carbonate minerals (e.g., dolomite, calcite, and aragonite). The near-saturation value for amorphous silica may be a result of silicate dissolution in areas where pyrite oxidation results in localized, acidic conditions. The partial pressure of carbon dioxide calculated from the mine water chemistry is approximately 10^{-2}, which is significantly greater than the partial pressure under atmospheric conditions ($10^{-3.5}$). The super-saturation of carbon dioxide is attributed to the dissolution of carbonate minerals.

3.2.4 Previous Geochemical Evaluations at the Crandall Canyon Mine

Multiple investigations have evaluated groundwater system associated with the Crandall Canyon Mine. These previous investigations are summarized below, followed by a comparison of the results from these previous investigations to the current mine water characteristics.

EarthFax Engineering 1992

EarthFax Engineering (1992) performed tritium and geochemical analyses on water samples to evaluate water sources in Joes Valley (Indian Creek) and the west-facing slope of East Mountain. Tritium analyses were performed for four springs along Indian Creek in Joes Valley: SP1-1a and SP1-47 in T15S R8E S34 and SP1-42a and SP1-37 in T16S R8E S3. Results of the tritium analyses ranged from 19.2 to 38.2 tritium units (TU), indicating mixture of old (pre-1952) and new water. Geochemical analyses were also performed for the four springs along Indian Creek plus three spring samples from the west-facing slope of East Mountain: springs SP1-31 and SP1-30a in T16S R8E S2 and an unnamed drainage in T15S R6E S35 N1/2 SW1/4. All groundwater samples were found to be a calcium-magnesium-bicarbonate type.

Mayo and Associates 1997

Mayo and Associates (1997a, 1997b) investigated groundwater conditions within Crandall Canyon Mine and the Joes Valley fault system. Isotope and geochemical analyses were performed for samples of groundwater collected in the Crandall Canyon #1 (Genwal) Mine February and June 1997. The 1997 study found that groundwater within the Joes Valley Fault system within the mine is generally thousands of years old with no component of modern water, and that the groundwater within the fault system is dissimilar to springs and creeks in the vicinity of the mine (Mayo and Associates 1997a, 1997b). A notable exception is a sample collected of water issuing from a fractured sandstone channel in the 5th West Fault approximately 100 m from Joes Valley fault, which had a tritium content of 0.95 TU, indicating hydraulic communication with surface water (Mayo et al. 2003). Monitoring wells (two) completed in 1997 to a depth of 105 feet each in the Spring Canyon member of the Star Point Sandstone in the mine found water to be ancient and calcium-magnesium-bicarbonate type. A monitoring well completed to 352 feet in the Panther Sandstone member of the Star Point Sandstone was found to be ancient and calcium-hydroxide type, with the chemical composition related to an adjacent igneous dike. Groundwater sampled from a well drilled upward approximately 94 feet into the Blind Canyon seam was found to be ancient and of calcium-magnesium-bicarbonate type (Mayo and Associates 1997b).

Petersen Hydrologic 2010

Petersen Hydrologic (2010) prepared a report attempting to demonstrate that iron concentrations in the mine water discharge are temporary and would decline within a few years. The report provides a series of plots showing total iron and total dissolved solids (TDS) concentrations queried from the Division's Water Quality Database. No sampling, analyses, calculations or geochemical modeling was performed to evaluate the nature and future trends of iron in the discharge.

The assessment of potential future trends of iron concentrations from the Crandall Canyon Mine was based on a comparison to a temporary increase in iron and total dissolved solids (TDS) following flooding of a portion of the Skyline Mine, located within the Wasatch Plateau coal field approximately 15 miles north of Crandall Canyon (Figure 1). Monitoring data from Skyline Mine sample location CS-14 illustrate a decline in iron concentrations beginning approximately four years after flooding. The 2010 Petersen Hydrologic report does not identify the area or extent of flooded workings at Skyline Mine used in the assessment; however, location CS-14 used for the assessment reportedly represents the mine discharge from "Mine No. 1" of the Skyline complex (Skyline MRP Section 2.3.7). The workings of Mine No. 1 are within the Upper O'Connor Seam, which is also referred to as the Wattis Seam (Tabet et al. 1999).

The four-year timeframe of elevated iron in mine water at Skyline is encouraging for the situation at Crandall; however, there are some significant differences between the mine water discharges at the two mines:

- The coal seam mined at Skyline Mine No. 1 is a different coal seam than mined at Crandall Canyon Mine;
- The mined-out areas of Skyline Mine which flooded dipped away from the mine portals, whereas at Crandall Canyon the mine portals are at a lower elevation than most of the mine workings.

- The Skyline discharge and its elevated iron concentrations were not brought about due to a catastrophic mine collapse, but were the result of a planned flooding of a mined-out area.
- Plots of water quality data from the Crandall Canyon Mine discharge and Skyline Mine CS-14 show noticeably different trends and magnitudes for TDS and total iron concentrations (Figure 5). The 2010 Petersen Hydrologic report does not offer an explanation of the variation in TDS and total iron concentrations and trends exhibited at the Skyline Mine compared to Crandall Canyon Mine.

Petersen Hydrologic's assertion that the there is a finite amount of reactants within the mine and that the total iron concentrations will begin to decline within a few years as the pyrite minerals are consumed through oxidation processes may very well be correct. However, asserting that the process will "likely occur within a few years" is problematic due to several unknown variables:

- The extent of pyritic material now exposed to oxygenated water is unknown;
- The actual source of the mine-water has never been determined. As a result, the amount of water that could potentially enter the mine and it's inherent oxygen content is also unknown;
- Whether the current flow path of the mine-water will remain in its current configuration is unknown. Due to the extensive faulting and mining in the area, it's likely that additional settling/movement of the mine will continue into the future. As a result, the flow path of the mine-water could be easily altered and previously non-exposed areas of pyritic material could become inundated with mine-water thus producing another spike in total iron;
- The observation that mine conditions did not support elevated iron concentrations during operation of the mine, therefore the mine is not expected to support iron discharge in the future neglects the considerations that mine water was carefully managed during operations and that the hydrologic system in the underground mine is now different due to the collapse and subsequent mine flooding. Since water management during active operations limits the interaction between the water and minerals, the water quality produced during active operations has limited use in predicting the water quality once water management ceases .

Based on the discussion presented in the Petersen Hydrologic report, if an evaluation of the amount of pyrite available for reacting and the availability of dissolved oxygen in the mine-water cannot be accomplished, it follows that the timeframe, rate and magnitude of reduction in iron concentrations cannot be predicted.

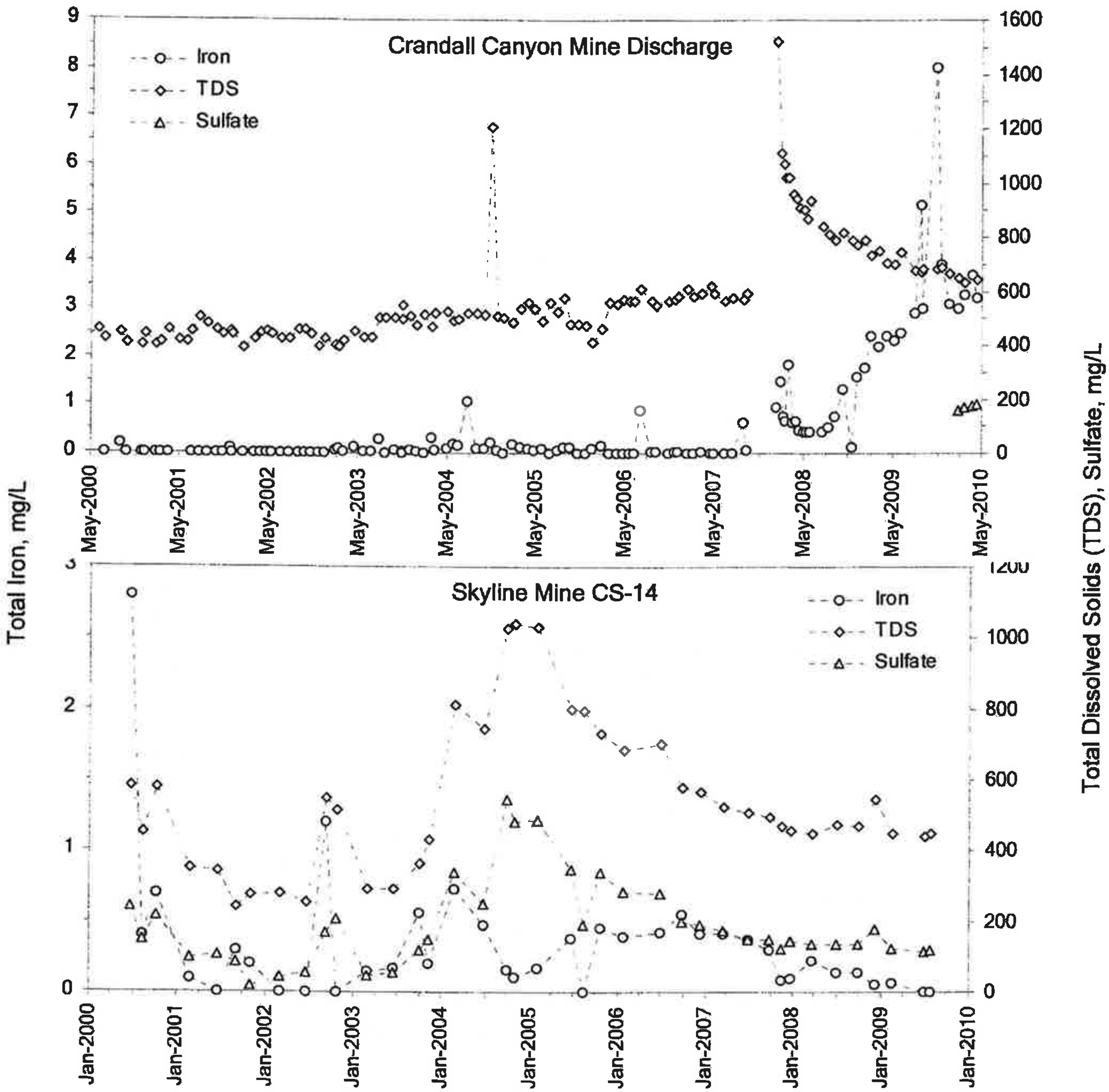


Figure 5. Plots Showing Water Quality Data from Crandall Canyon Mine and Skyline Mine CS-14

3.2.5 Comparison of Current Water Quality to Previous Investigations

The sulfate concentration measured in the mine discharge during January to March 2010 ranged from 159 mg/L to 183 mg/L (Table 5). Baseline sampling of the mine water discharge was not performed, therefore few sulfate data are available from prior to the 2007 mine collapse. Four mine water samples were analyzed in 1997 with reported sulfate concentrations ranging from not detected to 67 mg/L (Mayo and Associates 1997b). Danielson et al. (1981) evaluated the average sulfate composition of water-bearing units in the upper drainages of Huntington Creek and Cottonwood Creek and reported average sulfate concentrations ranging from 21 mg/L in the Blackhawk Formation to 77 mg/L in the Star Point Sandstone (Table 7).

Table 7. Sulfate Composition of Spring Waters from Different Water-Bearing Zones In and Adjacent to the Upper Drainages of Huntington and Cottonwood Creeks

		Dissolved Sulfate, mg/L			
	Unit	No. Samples	Average	Minimum	Maximum
Above Coal Seams	North Horn Formation	51	32	2.1	180
	Price River Formation	18	23	3.7	120
	Castlegate Sandstone	9	33	4.0	110
Contains Coal Seams	Blackhawk Formation	31	21	2.1	120
Below Coal Seams	Star Point Sandstone	19	77	13	300
	All Units	128	34	2.1	300

Source: Danielson et al. 1981

Based on the data identified, the sulfate composition of the mine water discharge is elevated compared to regional concentrations and mine water concentrations prior to the August 2007 collapse. The increased sulfate composition is likely a result of pyrite oxidation, which released sulfate and has been shown to contribute the majority of the increase in TDS and sulfate in an underground coal mine in the Wasatch Plateau (Mayo et al. 2000).

4 Mine Water Treatment System

In December 2009 the Operator began constructing a water treatment system to address the iron contamination in the mine water discharge. The water treatment system as built initially included a mechanical aeration unit (Maelstrom Oxidizer) and a lined settling basin. The Operator reportedly approached several engineering companies to discuss reverse osmosis, fine element filtration, and mechanical oxidation prior to selecting the aeration approach; however, no information from this screening process has been provided to the Division. No passive treatment technologies have been evaluated by the Operator. The design for the treatment system was based on a single bench test by the oxidizer unit manufacturer which indicated that following aeration, a settling time of 5.5 hours was sufficient to reduce total iron concentrations to below 1 mg/L. The treatment system came on-line January 2010, and it was immediately apparent that the iron precipitate generated by the oxidizer unit did not settle within the settling basin, which has a theoretical maximum retention time of approximately 9 hours at a flow rate of 500 gpm.

During February and March 2010 the Operator experimented with a variety of water treatment chemicals in an attempt to improve the settling of iron precipitate within the settling basin. The Operator was eventually able to achieve particle settling by using a combination of a polyaluminum chloride coagulant and a polyacrylamide flocculant in conjunction with the oxidizer unit. The treatment residual (sludge) generated by this process has a low solids content and accumulated rapidly within the settling basin. The sludge was cleaned out of the settling basin using vacuum trucks during April and May 2010. Prior to cleanout, the sludge was sampled and analyzed for RCRA metals, which were non-detected except for a low concentration of barium (0.825 mg/L).

In May 2010 the Operator installed a sludge recirculation system in an effort to reduce the amount of treatment chemicals and improve the density of the sludge. The sludge recirculation system has been difficult to realize due to short circuiting within the settling basin, which has a relatively flat bottom. Sludge is recirculated from the settling basin into the oxidizer unit. A process flow diagram showing the key components of the water treatment system is shown in Figure 6.

The treatment system operating at the site has been successful at reducing iron concentrations in the effluent to within the UPDES discharge limitation. However, the Division has several concerns about the treatment system, as follow:

- The operating cost for the treatment is not known with certainty; however, at current injection rates, the cost of the treatment chemicals alone is reported to be in the range of $100,000 to $200,000 annually.
- The system requires constant monitoring by the Operator in order to prevent release of iron to Crandall Creek. The system is highly mechanized, including three pumps, a blower, a mixer and heated storage unit, all of which require maintenance and are susceptible to power outages or other utility interruptions.
- Based on the initial operation results, sludge cleanout will be required as often as monthly. The low density of the sludge results in large quantities of sludge-water slurry, which requires disposal. No disposal facility is available at the Crandall Canyon Mine. Based upon a conversation between Division personnel and an on-site contractor at the Crandall Canyon water-treatment site (Division Inspection Report #2358, May 13th, 2010), 38 vacuum trucks, ranging in size from 5,000 gallon to 6,000 gallon capacities, were filled with sludge-water slurry from the treatment system's settling basin.

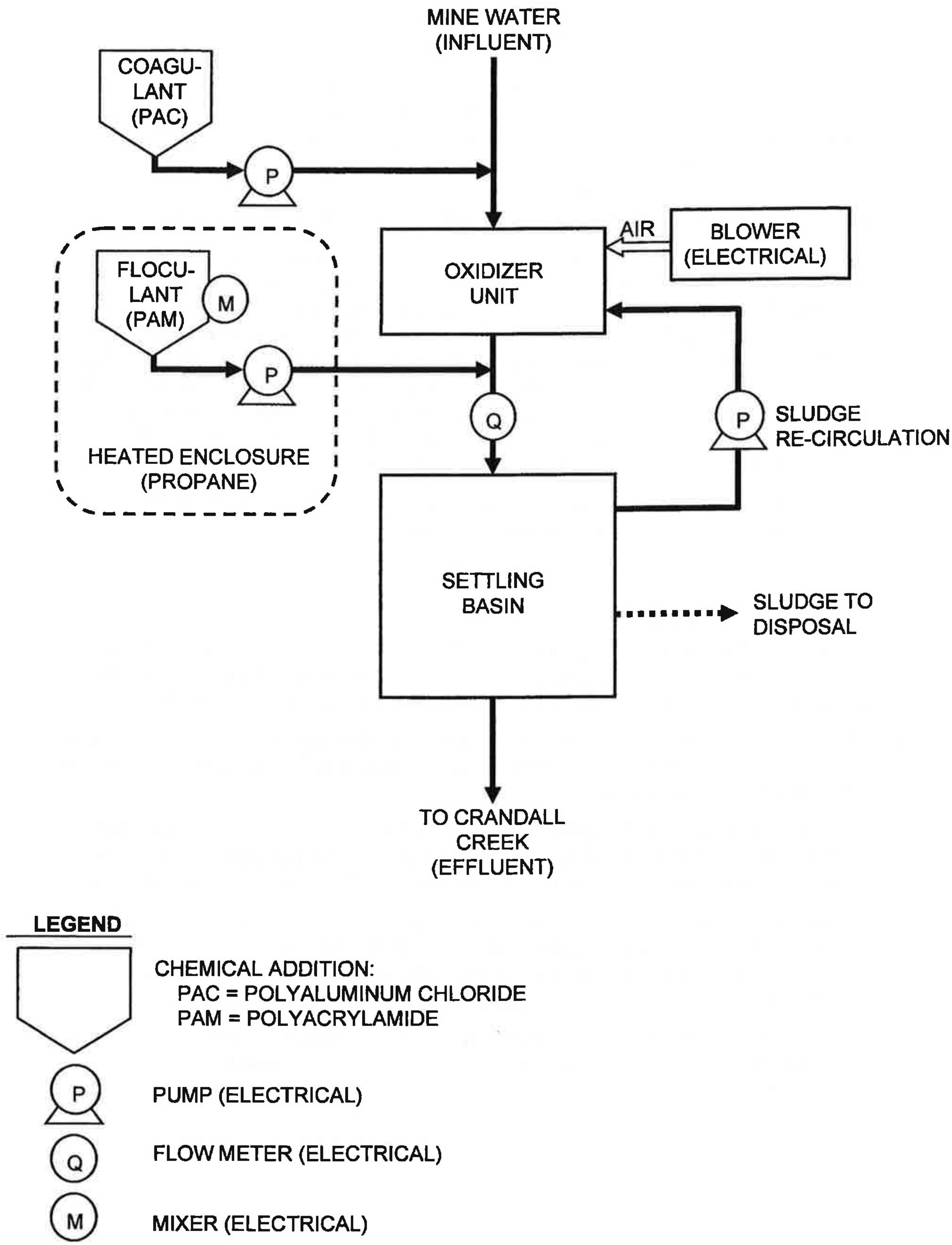


Figure 6. Crandall Canyon Mine Water Treatment System Process Flow Diagram

- Sludge-water slurry removed from the settling basin has been transported 45 miles to UEI's Wildcat Loadout facility (Figure 1). At Wildcat Loadout, the sludge-water slurry is transferred from the vacuum trucks directly into sediment pond "C" for drying and eventual disposal. UEI has indicated that ownership of the Wildcat Loadout facility will likely be transferred to IPA in the near future. An alternative disposal location for treatment residuals from the Crandall Canyon Mine has not been identified by UEI.
- The high-value aquatic habitat and municipal water supply downstream of the Crandall Canyon mine outfall heighten the sensitivity to the use of treatment chemicals. The treatment chemicals used contain constituents which are hazardous to aquatic life and human health. The polyacrylamide flocculant contains low-levels of acrylamide monomer, which is a known human carcinogen. The polyaluminum chloride coagulant contains aluminum, which can be highly toxic to aquatic life. Crandall Creek is classified as a cold water fishery, and is tributary to Huntington Creek, a popular destination for anglers. Flow from Huntington Creek is also diverted to a municipal water treatment system operated by the Castle Valley Special Services District.
- To date the Operator has not evaluated alternative treatment options for post-operational (e.g., reclamation) water treatment system at the site.

5 Findings

This hydrologic evaluation was prepared to address the conditions at the Crandall Canyon Mine and the potential for perpetual discharge of mine water containing elevated concentrations of iron. Based on this hydrologic evaluation, the Division makes the following findings:

- The Crandall Canyon Mine has been discharging water for approximately 14 years. There has been no indication of diminution of flow, nor is there any indication that the flow will diminish in the foreseeable future.
- Pyrite is present in the coal and the strata above and below coal seams at the Crandall Canyon Mine. The amount of pyrite available underground and the extent to which this pyrite has become exposed to groundwater as a result of the mine collapse is unknown.
- The mine water contains elevated concentrations of iron and sulfate, consistent with the oxidation of pyrite. There has been no indication that the rate of pyrite oxidation is slowing; sulfate concentrations have been relatively constant and iron concentrations have not declined.
- The available data support the likelihood of a perpetual discharge of mine water containing elevated concentrations of iron which will require treatment into the foreseeable future.

6 Recommendations

The following recommendations are based on the Hydrologic Evaluation completed by the Division for the Crandall Canyon Mine water discharge:

I. The Operator has not collected sufficient hydrologic information for the mine water discharge. The hydrologic information is necessary to plan remedial and reclamation activities that will effectively address adverse impacts from the mine water discharge. The Operator must collect additional information on the chemistry and flow of the mine water discharge in accordance with R645-301-724.500. The discharge rate from the sealed portals must be monitored either continuously (e.g., using a data logger) or at a minimum recorded daily. Whole-water chemical analysis and field measurements of the untreated mine discharge must be performed monthly and shall include the following parameters:

- calcium (dissolved)
- potassium (dissolved)
- sodium (dissolved)
- magnesium (dissolved)
- silica
- chloride
- hot acidity by Standard Method 2310B 4(a)
- aluminum (total & dissolved)
- iron (total & dissolved)
- manganese (total & dissolved)
- sulfate
- alkalinity (total, carbonate & bicarbonate)
- TDS
- suspended solids
- ferrous iron (field)
- pH (field)
- dissolved oxygen (field)
- conductivity (field)
- temperature (field)
- flow (field)

The Operator currently samples the mine water discharge prior to and following treatment for a subset of the parameters listed above. The additional parameters are necessary to evaluate the feasibility of treatment options, to provide information for treatment system design, and to provide baseline information for evaluating potential changes in the discharge over time.

II. The Probable Hydrologic Consequences (PHC) determination in the Crandall Canyon Mine MRP clearly does not reflect the conditions at the site. Toxic-forming materials are present at the site and coal-mining operations have resulted in impacts to surface water. In accordance with R645-301-728.400, the Operator must prepare a new or updated PHC determination to address mine water discharge. The PHC must address impacts to both water quality and aquatic habitat within Crandall Creek and Huntington Creek and incorporate results from macroinvertebrate surveys and stream surveys to be completed per MRP Section 3 and Appendix 7-65, respectively. In accordance with R645-301-731.221, the new or revised PHC must include recommendations for surface water monitoring. The Division will revisit the Cumulative Hydrologic Impact Analysis (CHIA) for the site to determine whether an update is required, based on the revised PHC.

III. In accordance with R645-301-724.500, the Operator must conduct and submit to the Division the results of investigations and studies relevant to the feasibility of additional options for perpetual treatment of the mine discharge by completing a Treatment Study. The purpose of the Treatment Study is to provide the data required for designing and bonding a perpetual treatment system at Crandall Canyon mine. The Treatment Study must be completed by a qualified professional or firm with direct experience in the treatment of alkaline mine drainage.

The Treatment Study must include technology pre-screening and treatability testing:

Technology pre-screening - A technology pre-screening evaluation will be completed to assess the potential feasibility of treatment technologies. The pre-screening evaluation should include a review of site data, treatment technology literature and case study review, and consultation with technology experts. The technology pre-screening must evaluate passive, low-energy and active conventional treatment technologies and may include innovative treatment technologies. A list of treatment technologies to be evaluated in the pre-screening will be provided to the Division and the USFS for review. For each treatment technology, the pre-screening evaluation will provide a basic description, feasibility for implementation, potential for modifications, and cost data. The pre-screening evaluation will also identify data needs when additional data or testing is necessary to assess the feasibility of treatment technologies.

Treatability testing - Treatability testing will be performed to address the data needs identified by the pre-screening evaluation and to generate data for assessing the potential effectiveness and costs associated with treatment alternatives. Treatability testing is not necessary for technologies when site conditions and/or available literature are adequate for assessing the feasibility of a technology; however, any technology recommended for the perpetual treatment system must be supported by treatability testing to evaluate the effectiveness and costs.

IV. In accordance with R645-301-526, the Operator must revise the MRP to accurately describe the Operational treatment system, including as-built figures, treatment chemical information, and system operations and maintenance.

V. Genwal Resources, Inc. is required in accordance with R645-301-830.140 to provide the Division a detailed summary of the costs associated with the operational system for the purpose of updating the bond required for the permit. Costs must include capital, operations, and maintenance.

7 References

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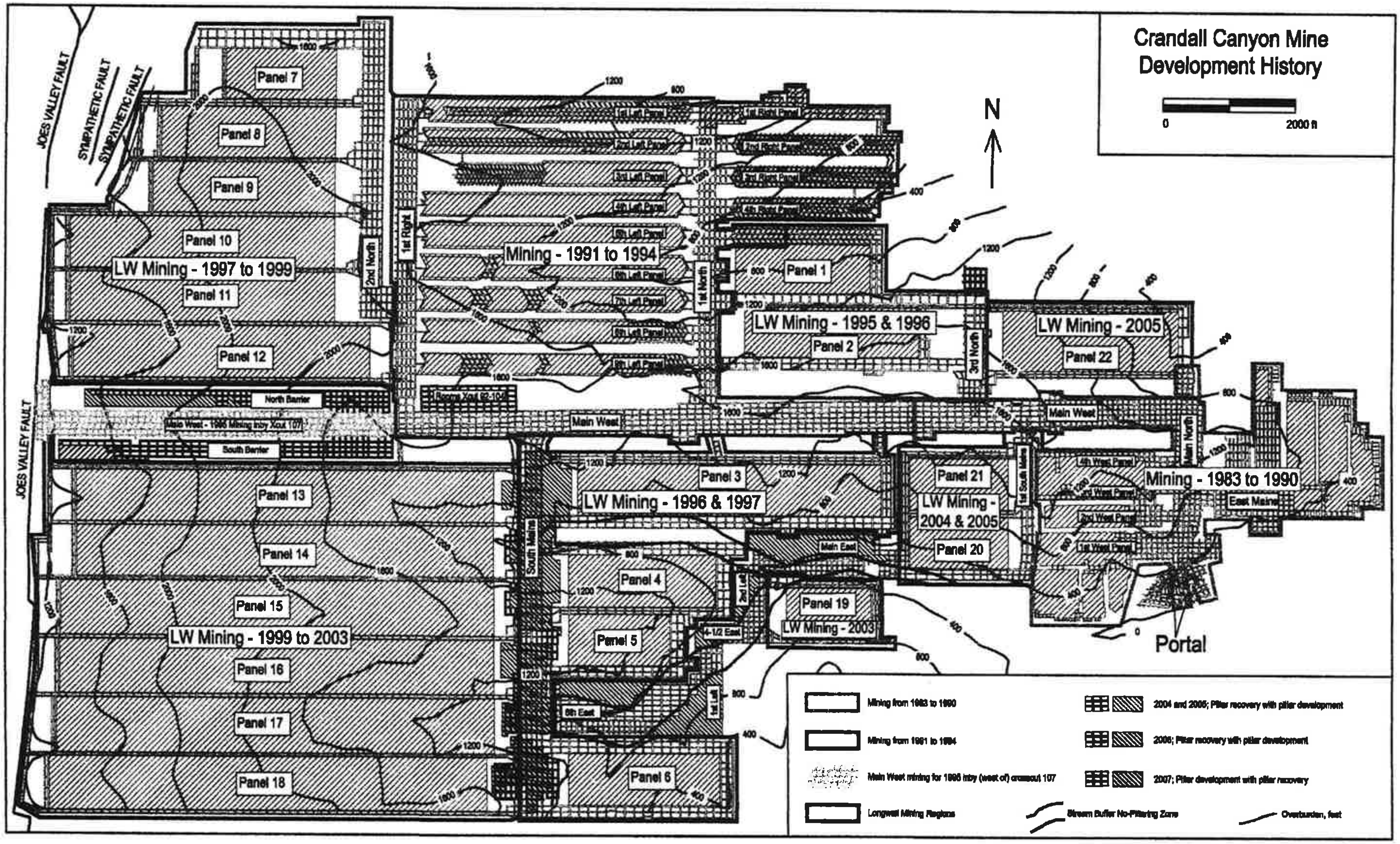
Attachment 1.

Crandall Canyon Mine Development History

Appendix D - Mine Development History Map



Attachment 2.

September 20, 2007 Letter re: Temporary Cessation of Coal Mining and Reclamation Operations Genwal Mine 015/032

0038

GENWAL™ RESOURCES, INC.

PO Box 1077, Price Utah 84501
(435) 888-4000 Fax (435) 888-4002

CONFIDENTIAL

This is not Confidential pgl 10/2/07

Incoming C/015/0032 copy PGL ok

September 20, 2007

Pam Grubaugh-Littig
Permit Supervisor
1594 West North Temple, Suite 1210
P.O. Box 145801
Salt Lake City, Utah 84114-5801

Re: Temporary Cessation of Coal Mining and Reclamation Operations Genwal Mine 015/032

Dear Ms. Grubaugh-Littig,

As per R645-301-515.300 to R645-301-515.321 and R645-301-320 the following notice is given:

As you are aware, the Crandall Canyon #1 Mine experienced a severe seismic event on August 6, 2007. Another significant seismic event was experienced on August 16, 2007. These events have lead to production being idled at both Crandall Canyon #1 and South Crandall Mines. At this time the extent of the damage caused by the accident and the corrective action to be taken is unknown. This idling or cessation is to be considered temporary but its duration is unknown.

The number of disturbed acres in the permit is 15.264 the total permit acres is 6,287.74 this will not change during the temporary cessation.

After the equipment is removed from both North and South Crandall mines, Concrete block walls will be installed in all openings to underground operations. The block walls will be constructed to prevent water from being impounded behind the walls. Mine discharge, if any, is expected to meet NPDS discharge standards. Environmental monitoring will continue as per approved MRP during the temporary cessation.

All equipment will be removed from both mines. Most but not all of the conveyor belting, conveyor structure, and water pipe will be removed. A certified list of best known locations of equipment being left underground will be provided as required for CIRCLA certification.

A chain link fence will be installed a minimum of 50 feet from the mine portals to prevent unauthorized access. The building and surface facilities will be locked and plating installed to prevent unauthorized access. In addition, a security guard will patrol the site around the clock.

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SEP 27 2007
DIV. OF OIL, GAS & MINING

GENWAL™
RESOURCES, INC.

PO Box 1077, Price Utah 84501
(435) 888-4000 Fax (435) 888-4002

The actions outlined in this letter are being implemented to protect the mine through out the investigation and pending studies. All applicable information from the investigation and studies will be forwarded to DOGM when they are finalized. DOGM will be kept informed of all developments that occur at the aforeferenced mines.

Sincerely,

David W. Hibbs

David W. Hibbs
Director, Engineering

Mile Post 33, Huntington Canyon
Huntington, Utah 84528

Attachment 3.

March 30, 2010 Letter re: Minor Modification to Resource Recovery and Protection Plan (R2P2), Revised Mining Plans with Timing, North and South Crandall Mines, UtahAmerican Energy, Inc. (UEI)

0018

C/015/032 Incoming
map to Confidential
cc: Steve C,
Karl

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Utah State Office
P.O. Box 45155
Salt Lake City, UT 84145-0155
http://www.blm.gov

TAKE PRIDE IN AMERICA

MAR 30 2010

IN REPLY REFER TO:

3480
UT (923)
SL-062648
UTU-68082
UTU-78953

File in: C0150032 2010 Incoming
Refer to:
X Confidential
☐ Shelf
☐ Expandable
Date 03 30 10 For additional information

Certified Mail—Return Receipt Requested 7008 1140 0002 1095 0824

Mr. David W. Hibbs
Director, Engineering
UtahAmerican Energy, Inc.
P.O. Box 910
East Carbon, Utah 84520

RECEIVED
APR 01 2010
DIV. OF OIL, GAS & MINING

Re: Minor Modification to Resource Recovery and Protection Plan (R2P2), Revised Mining Plans with Timing, North and South Crandall Mines, UtahAmerican Energy, Inc. (UEI)

Dear Mr. Hibbs:

The Bureau of Land Management (BLM) has received submissions to modify the R2P2 for both subject mines that comprise the Crandall Canyon Logical Mining Unit (LMU) application. The modification revises the timing of the mining plan for a projected mine start-up date in 2012 and changes the mining method in the South Crandall Mine from longwall mining to room and pillar mining. The proposed revisions are on Federal coal leases UTU-68082 and UTU-78953.

Proposed Plan: With the idling of the Crandall Mines, UEI has now submitted revised mining plans for a projected restart of mining operations in 2012. They also propose changing the mining method for the South Crandall Mine to room and pillar panels in the areas where longwall panels were previously approved.

Approval: The BLM has reviewed the revised R2P2 and is in agreement with the proposal. The change from longwall mining panels to room and pillar panels in the South Crandall Mine will provide for Maximum Economic Recovery (MER) in thin coal conditions. BLM approved a cessation of longwall operations in South Crandall in 2006 as the existing longwall equipment was producing coal that was not meeting quality limits. Coal thickness was less than anticipated and was thinner than the minimum cutting range of the longwall shearer. Changing over to room and pillar panels in the same area that was planned for longwall mining, will afford a better chance of mining an acceptable coal quality product with low profile continuous mining equipment.

Maximum Economic Recovery (MER): The extraction of the Federal coal following this plan will achieve MER.

Recoverable Reserve: For the dated locations shown in color on the attached approved map dated March 30th 2010, the remaining Federal recoverable reserves are 990,000 tons for the North Crandall Mine and 2,036,000 tons for the South Crandall Mine. However, the mine plan approved previously (approval dated February 23rd 2004) continues in effect for all other areas of the Crandall Mines which contain additional recoverable reserves.

National Environmental Policy Act (NEPA): As mining will occur in the same areas that were previously approved for mining, no new surface disturbance is predicted and is therefore Categorically Excluded (CX) from NEPA analysis under DM 516 chapter 11.5, paragraph F. (8): Approval of minor modifications to, or minor variances from, activities described in an approved underground or surface mine plan for leasable minerals.

This R2P2 modification complies with the Mineral Leasing Act of 1920, as amended, the regulations at 43 CFR 3480, and the lease terms and conditions. If you have any questions, please contact Stephen Falk at the Price Field Office at (435) 636-3605 or Jeff McKenzie of my staff at (801) 539-4038.

/s/ Roger L. Bankert

Roger L. Bankert
Chief, Branch of Minerals

Enclosure: Approved Mine Map

cc: PFO
Utah Division of Oil, Gas, and Mining (Attn. Daron Haddock), 1594 West North Temple, Suite 1210, Box 145801, Salt Lake City, UT 84114-5801
Files - UTU-68082
Chron File

N and S crandalnewtimining 25 Mar 2010JM-SA

Attachment 4.

Geochemist's Workbench Input & Output Summary

```
Step #      0            Xi = 0.0000
Temperature =  10.5 C    Pressure =  1.013 bars
pH =  7.550
Ionic strength        =   0.015755
Activity of water     =   0.999992
Solvent mass          =   1.000000 kg
Solution mass         =   1.000896 kg
Solution density      =   1.023    g/cm3
Chlorinity            =   0.000215 molal
Dissolved solids      =        895 mg/kg sol'n
Hardness              =     478.06 mg/kg sol'n as CaCO3
  carbonate           =     380.00 mg/kg sol'n as CaCO3
  non-carbonate       =      98.06 mg/kg sol'n as CaCO3
Rock mass             =   0.000000 kg
Carbonate alkalinity=       380.00 mg/kg sol'n as CaCO3
Water type            =   Ca-HCO3
```

No minerals in system.

Aqueous species	molality	mg/kg sol'n	act. coef.	log act.
HCO3-	0.007315	445.9	0.8866	-2.1881
Ca++	0.002119	84.86	0.6310	-2.8738
Mg++	0.002019	49.03	0.6492	-2.8825
Na+	0.001474	33.86	0.8847	-2.8846
SO4--	0.001343	128.8	0.6108	-3.0862
SiO2(aq)	0.0005769	34.63	1.0043	-3.2371
CO2(aq)	0.0005341	23.48	1.0000	-3.2724
K+	0.0002146	8.383	0.8807	-3.7235
Cl-	0.0002121	7.513	0.8807	-3.7286
CaSO4	0.0002113	28.74	1.0000	-3.6751
MgSO4	0.0001669	20.06	1.0000	-3.7777
CaHCO3+	0.0001483	14.98	0.8892	-3.8798
MgHCO3+	9.368e-005	7.986	0.8847	-4.0816
NaHCO3	1.524e-005	1.279	1.0000	-4.8171
Fe++	1.455e-005	0.8117	0.6310	-5.0372
CaCO3	1.331e-005	1.331	1.0000	-4.8758
CO3--	1.218e-005	0.7300	0.6160	-5.1249
MgCO3	5.861e-006	0.4937	1.0000	-5.2320
NaSO4-	5.538e-006	0.6587	0.8847	-5.3098
H3SiO4-	2.257e-006	0.2145	0.8847	-5.6997
FeHCO3+	1.965e-006	0.2295	0.8847	-5.7597
CaCl+	1.960e-006	0.1479	0.8847	-5.7610
Mn++	1.883e-006	0.1033	0.6310	-5.9252
KSO4-	1.199e-006	0.1619	0.8847	-5.9744
FeSO4	1.179e-006	0.1790	1.0000	-5.9284
FeCO3	8.271e-007	0.09574	1.0000	-6.0825
MgCl+	4.964e-007	0.02964	0.8847	-6.3574
MgH3SiO4+	1.557e-007	0.01857	0.8847	-6.8610
MnHCO3+	1.530e-007	0.01772	0.8847	-6.8686
MnSO4	1.455e-007	0.02196	1.0000	-6.8370
OH-	1.243e-007	0.002113	0.8828	-6.9596
CaH3SiO4+	9.020e-008	0.01218	0.8847	-7.0980
Mg2CO3++	5.771e-008	0.006263	0.6211	-7.4456
NaCO3-	5.105e-008	0.004234	0.8847	-7.3452
MnCO3	4.085e-008	0.004692	1.0000	-7.3888
NaH3SiO4	3.821e-008	0.004509	1.0000	-7.4178
H+	3.127e-008	3.149e-005	0.9012	-7.5500
MgOH+	2.179e-008	0.0008994	0.8847	-7.7149
FeOH+	1.053e-008	0.0007663	0.8847	-8.0308
MgH2SiO4	1.007e-008	0.001191	1.0000	-7.9969

(only species > 1e-8 molal listed)

Mineral saturation states

	log Q/K		log Q/K
Minnesotaite	2.3495s/sat	Magnesite	-0.3454
Dolomite-ord	1.9452s/sat	Amrph^silica	-0.3676
Dolomite	1.9452s/sat	Greenalite	-0.3730
Quartz	1.0407s/sat	Monohydrocalcite	-0.3982
Tridymite	0.8607s/sat	Rhodochrosite	-0.4930
Chalcedony	0.7555s/sat	Ferrosilite	-1.1219
Talc	0.7289s/sat	Gypsum	-1.4968
Calcite	0.5695s/sat	Anhydrite	-1.8191
Cristobalite	0.4562s/sat	FeO(c)	-2.1348
Aragonite	0.4029s/sat	Huntite	-2.3143
Dolomite-dis	0.2906s/sat	Bassanite	-2.4521
Siderite	0.2728s/sat	CaSO4^1/2H2O(bet	-2.6391

(only minerals with log Q/K > -3 listed)

Gases	fugacity	log fug.
Steam	0.01249	-1.903
CO2(g)	0.009933	-2.003

		In fluid		Sorbed		Kd
Original basis	total moles	moles	mg/kg	moles	mg/kg	L/kg
Ca++	0.00249	0.00249	99.9			
Cl-	0.000215	0.000215	7.60			
Fe++	1.85e-005	1.85e-005	1.03			
H+	0.000499	0.000499	0.503			
H2O	55.5	55.5	9.99e+005			
HCO3-	0.00814	0.00814	496.			
K+	0.000216	0.000216	8.43			
Mg++	0.00229	0.00229	55.5			
Mn++	2.22e-006	2.22e-006	0.122			
Na+	0.00150	0.00150	34.3			
SO4--	0.00173	0.00173	166.			
SiO2(aq)	0.000579	0.000579	34.8			

Elemental composition		In fluid		Sorbed	
	total moles	moles	mg/kg	moles	mg/kg
Calcium	0.002494	0.002494	99.88		
Carbon	0.008140	0.008140	97.69		
Chlorine	0.0002146	0.0002146	7.600		
Hydrogen	111.0	111.0	1.118e+005		
Iron	1.853e-005	1.853e-005	1.034		
Magnesium	0.002286	0.002286	55.52		
Manganese	2.223e-006	2.223e-006	0.1220		
Oxygen	55.54	55.54	8.878e+005		
Potassium	0.0002158	0.0002158	8.430		
Silicon	0.0005794	0.0005794	16.26		
Sodium	0.001495	0.001495	34.34		
Sulfur	0.001729	0.001729	55.37		

Exhibit B

Hydrologic Evaluation Update
June 2, 2011

Crandall Canyon Mine Hydrologic Evaluation Update
June 2, 2011

Introduction

The Division of Oil, Gas and Mining (the Division) completed a Hydrologic Evaluation of the Crandall Canyon Minewater Discharge in June 2010 (attached). Since that time, additional minewater flow and chemistry data have been collected by Genwal Resources, Inc. (Genwal) and the Division. This report presents an update to the Hydrologic Evaluation based on data collected through mid-May 2011.

It has been generally accepted by Genwal and the Division that the source of the elevated iron concentrations in the minewater discharge is the oxidation of sulfide minerals (e.g., pyrite). The oxidation of pyrite (FeS_2) in an oxygenated aqueous environment proceeds according to the following reaction:

$$FeS_2 + {}^7/_2O_2 + H_2O = Fe^{2+} + 2SO_4^{2-} + 2H^+$$

The reaction above shows that when pyrite is oxidized, ferrous iron (Fe^{2+}), sulfate (SO_4^{2-}) and acidity (H^+) are released. Acidity generated by the reaction is consumed by excess alkalinity available from the dissolution of carbonate minerals, which are prevalent in the Wasatch plateau.

Genwal's consultant has opined that elevated iron concentrations will not persist for more than approximately 10 years (Task ID 3724, received January 6, 2010) and that iron concentrations will decline as a result of either depletion of pyrite or oxygen, which are the reactants for pyrite oxidation. Genwal's consultant has not offered any other potential explanation for variation in minewater iron concentrations over time, nor has a stoichiometric analysis of minewater chemistry been performed.

The following sections of this update report describe the data which have been collected and the plots which have been prepared to examine the data. A series of conclusions are then presented which describe the characteristics of the Crandall Canyon minewater discharge based on the monitoring data.

Presentation of Data

Genwal has continued to perform monthly sampling and analysis of the minewater discharge in accordance with the Crandall Canyon Mining and Reclamation Plan (MRP). Minewater chemistry analytical results are tabulated in Table 1. Beginning in March 2011, additional sampling was performed by both the Genwal and the Division to gain additional information on the variability in minewater chemistry during the 90-day negotiation period established by the Board of Oil, Gas and Mining (the Board) during the February 2011 Board Hearing. Samples collected as part of the weekly sampling program were analyzed for a reduced set of parameters, including only total iron and sulfate. Weekly sampling results from Genwal's laboratory are included in Table 1. Iron and sulfate concentrations from January 2008 through

May 2011 are plotted in Figure 1. Additional detail for total iron and sulfate concentrations from the Negotiation Period sampling is shown in Figure 2. A side-by-side comparison of Genwal's results and results obtained by the Division for samples analyzed at the Utah Unified State Laboratory is presented in Table 2.

To evaluate the potential correlation of total iron concentrations with other variables, a series of scatter plots is presented in Figure 3. Scatter plots a through c present the total iron concentration in minewater (y-axis) versus discharge rate, sulfate concentration and total dissolved solids (TDS) (x-axes). Scatter plot d presents TDS versus sulfate concentration. The minewater which initially discharged from the portals contained elevated concentrations of total iron, sulfate and TDS (Table 1 and Figure 1). Concentrations of these constituents dissipated, then began increasing in July 2008. The scatter plots for total iron versus discharge rate (plot a) and TDS (plot c) differentiate between the initial flush water (prior to July 2008) as opposed to minewater discharge since July 2008. Minewater was not analyzed for sulfate until January2010.

The Operator began recording the minewater discharge rate daily (in gallons per minute, or gpm) in January 2010, and began recording the discharge rate twice per day in April 2010. Flow measurements prior to March 19, 2010 were read from a malfunctioning flow meter and are suspect. A new flow meter was installed on March 19, 2010 at the outlet of the oxidizer unit. At this location, measured flows reflect both the minewater discharge rate and sludge recirculation. Between March and June 2010, the Operator was experimenting with sludge recirculation at varying rates. After June 10, 2010, sludge recirculation was performed continuously at a rate of approximately 520 gpm. Minewater discharge rates for January 2010 to May 2011 are shown in Figure 4. These discharge rates have been corrected for sludge recirculation, when possible.

Minewater Discharge Characteristics

The following conclusions are drawn from the data presented in Tables 1 and 2 and the plots presented in Figures 1 through 4:

1. Total iron concentrations in minewater have exceeded the UPDES discharge limit (1.0 mg/L prior to May 1, 2011; 1.2 mg/L after May 1, 2011) continuously since December 2008. Total iron concentrations detected during the March to May 2011 Negotiation Period ranged from 2.05 mg/L to 6.68 mg/L[1].
2. The plot of total iron concentrations over time (Figure 1) shows that iron levels have been generally lower during the four-month period February 2011 to May 2011 (usually in the range of 2 mg/L to 2.5 mg/L) than during the previous four months (between about 2.8 to 3.3 mg/L October 2010 to January 2011). However, the minewater sample from April 27, 2011 contained 6.68 mg/L total iron, which is the second highest concentration detected in the minewater to date. Recent sulfate concentrations are not lower than earlier results.

[1] This is the range of concentrations reported for samples analyzed by Genwal. Total iron concentrations in samples analyzed by the Division ranged from 1.98 mg/L to 5.0 mg/L. For simplicity and consistency, concentrations discussed in this section are for monitoring data collected by Genwal.

3. Iron and sulfate concentrations in the minewater are variable, although iron concentrations are much more highly variable than sulfate concentrations. The coefficients of variation (standard deviation divided by average, unitless) for data collected by Genwal March 10 through May 17, 2011 (Figure 2) are 0.45 for total iron and 0.03 for sulfate.
4. The scatter plots presented in Figure 3 suggest that total iron concentration is not correlated with minewater discharge rate (plot a) or with sulfate concentrations (plot b). Total iron concentrations show a potential negatively correlation with TDS concentrations (plot c). A strong correlation between TDS and sulfate concentration is not indicated (plot d), although the data do suggest that TDS may be positively correlated with sulfate concentrations.
5. Visual inspection of the plot of total iron concentrations from the March to May 2011 Negotiation Period (Figure 2) does not suggest that iron concentrations are decreasing over time. Sulfate concentrations reported for March to May 2011 also do not appear to be decreasing.
6. The analytical results for general chemistry parameters in Table 1 (sodium, potassium, calcium, magnesium, chloride, silica, aluminum, manganese, alkalinity) have been consistent since whole-water analysis of the minewater was initiated in April 2010.
7. Iron oxidation and precipitation is occurring within the mine, prior to treatment. This conclusion is based on the dissolved oxygen content of the minewater, lower concentrations of dissolved iron / ferrous iron compared to total iron, and the chemical behavior of iron at the pH and redox conditions of the minewater (Hem 1985). As such, iron is considered a non-conservative parameter. Sulfate is considered to be much more conservative. The geochemical evaluation presented as Attachment 4 of the June 2010 Hydrologic Evaluation Report found the minewater to be undersaturated for sulfate minerals, therefore sulfate precipitation is not expected to be occurring within the mine workings. If depletion of pyritic source material or dissolved oxygen were occurring, then the concentration of sulfate, which is a product of pyrite oxidation and more conservative that iron, would be expected to decrease[2]. Monitoring data have not shown a decrease in sulfate concentrationssince sulfate analysis was initiated in January 2010 (Figure 1).
8. The relatively stable concentrations of sulfate, a product of pyrite oxidation and a quasi-conservative dissolved constituent, indicate that reductions in total iron concentrations may not be due to depletion of either available pyrite or dissolved oxygen contacting pyrite. The total iron concentrations may be attenuated by other processes, such as precipitation within the mine workings (as iron oxy-hydroxide or iron carbonate), adsorption to iron hydroxides, or cation exchange. Whereas depletion of pyrite reactant is essentially an irreversible reaction, the other potential attenuation mechanisms (adsorption, precipitation) retain iron within the mine workings and could allow the mobilization of iron as a result of physical or chemical changes in the mine workings.

[2] Pyrite oxidation is not the only source of sulfate present in the hydrologic system potentially contributing to the minewater discharge; however, in a study completed for the SUFCO mine in the Wasatch Plateau, Mayo, Petersen and Krazitz (2000) found that most sulfate in minewater discharge results from pyrite oxidation.

9. Minewater discharge rates are variable (Figure 4). The average discharge rate for the period January 2010 to May 2011 was 457 gpm, with a standard deviation of 79 gpm. The time series data for minewater discharge shown on Figure 4 do not suggest a trend in discharge rates over time, but do indicate potential seasonal or weather-related variability.

Conclusions

Monitoring data collected since the June 2010 Hydrologic Evaluation Report have shown total iron concentrations in the minewater discharge to be quite variable. The recent detections of iron at concentrations of about 2 mg/L (compared to previous detections of about 3 mg/L) is encouraging, as this suggests attenuation may be occurring within the mine and that iron levels may drop below the UPDES criterion of 1.2 mg/L. However, the available monitoring data do not show a strong decreasing trend in minewater iron concentrations. The attenuation mechanisms proposed by Genwal - depletion of either pyrite or oxygen – are not supported by the minewater chemistry data. Furthermore, Genwal has not submitted a technical demonstration supporting a known timeframe for iron concentrations to decline, and stay below, the UPDES criterion. Absent such a demonstration, and based on the minewater discharge chemistry observed to date, it is reasonable to assume that continued treatment of minewater discharge will be required and that the duration of the treatment is unknown at this time.

References

Hem, J.D. 1985. Study and Interpretation of the Chemical Characteristics of Natural Water, Third Edition. U.S. Geological Survey Water-Supply Paper 2254. 264 pages.

Mayo, A.L., Petersen, E.C., and C. Kravatis. 2000. Chemical Evolution of Coal Mine Drainage in a Non-Acid Producing Environment, Wasatch Plateau, Utah, USA. Journal of Hydrology 236 (2000) 1-16.

O:\015032.CRA\Hydrologic Evaluation- Mine Water Discharge\Update June 2011\Hydro_Eval_2.doc

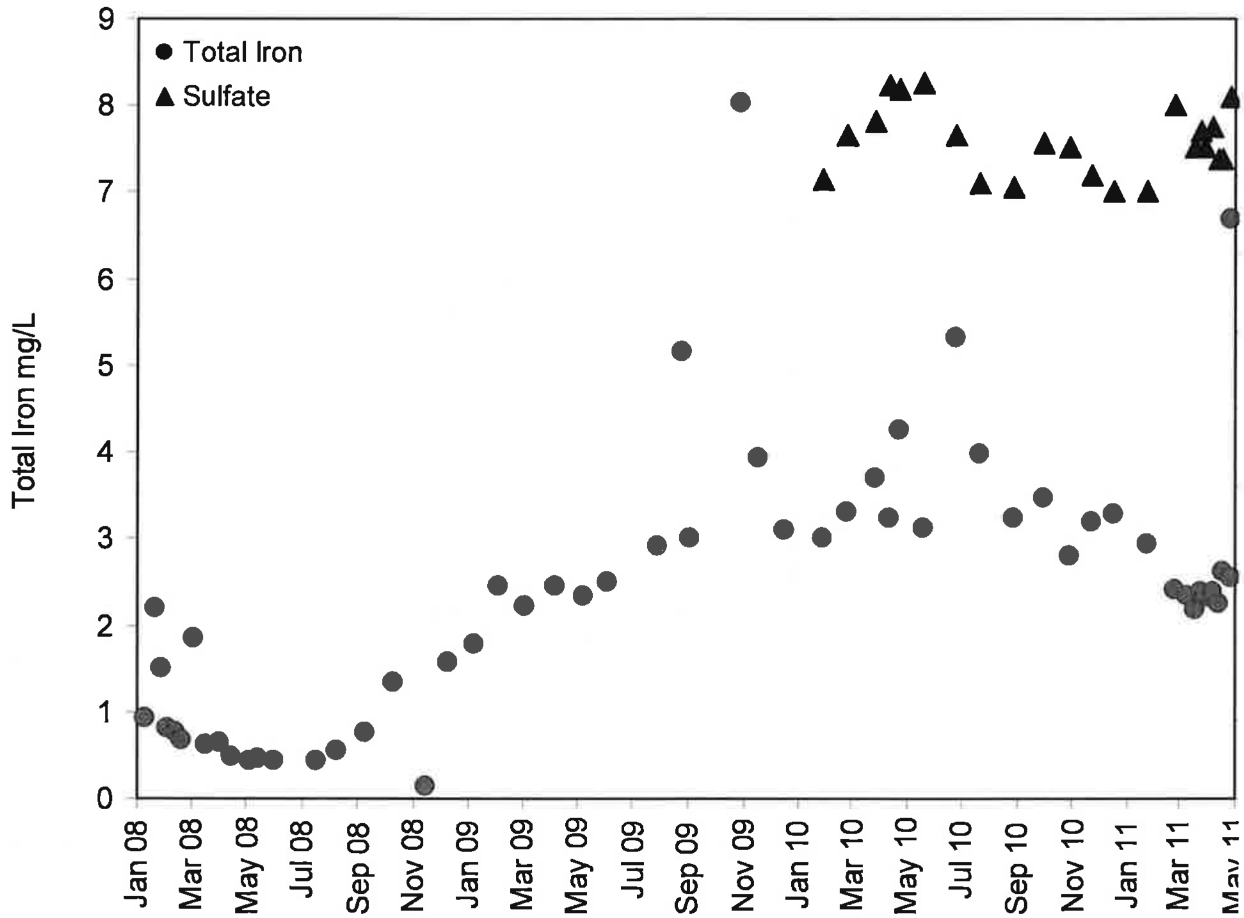

Figure 1. Minewater Total Iron and Sulfate Concentrations January 2008 to May 2011 (Data Collectec

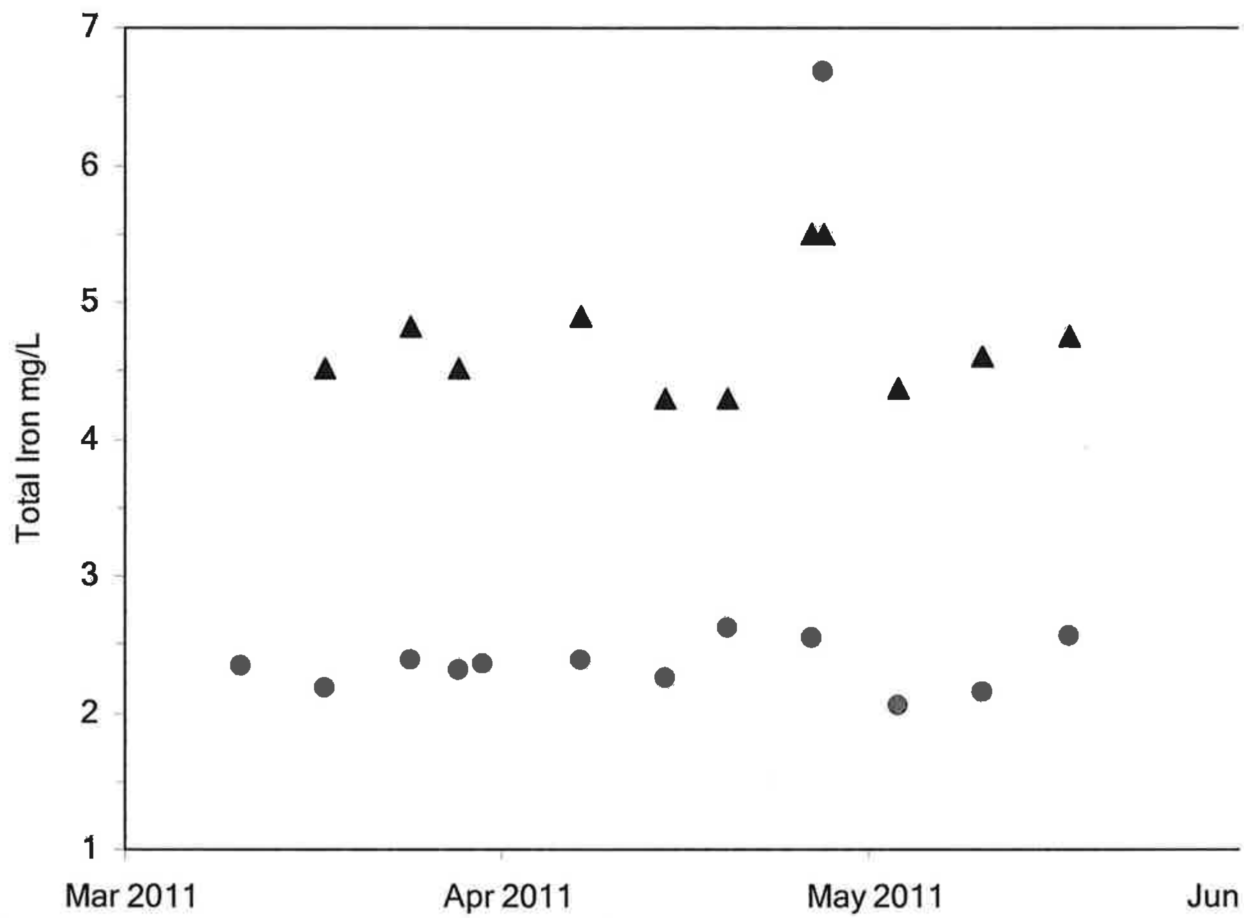

Figure 2. Minewater Total Iron and Sulfate Concentrations March 2011 to May 2011 (Data Collected I

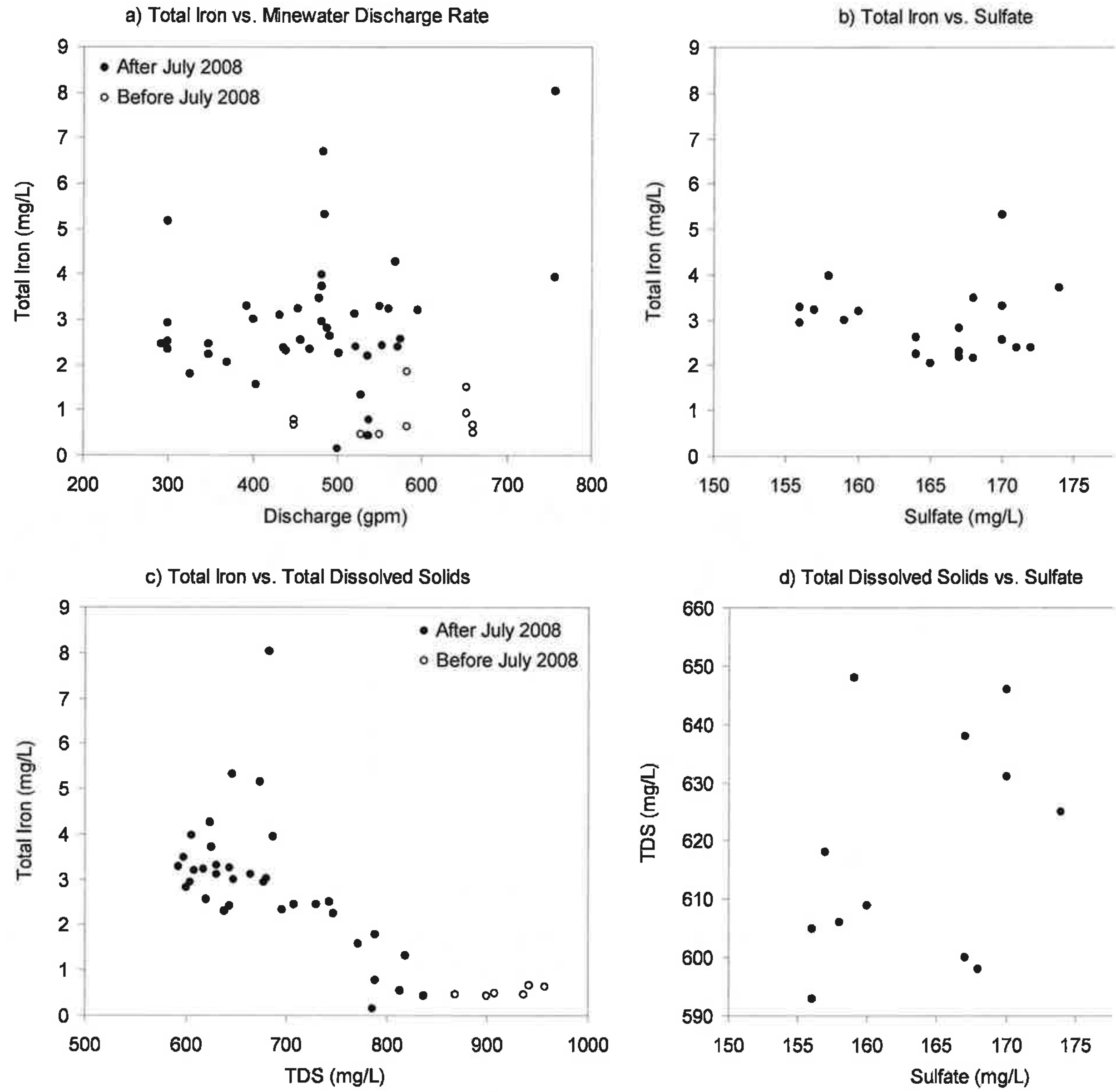

Figure 3. Scatter Plots for Minewater Discharge Characteristics Showing: a) Total Iron vs. Flow, b) Tc c) Total Iron vs. TDS, and d) TDS vs. Sulfate.

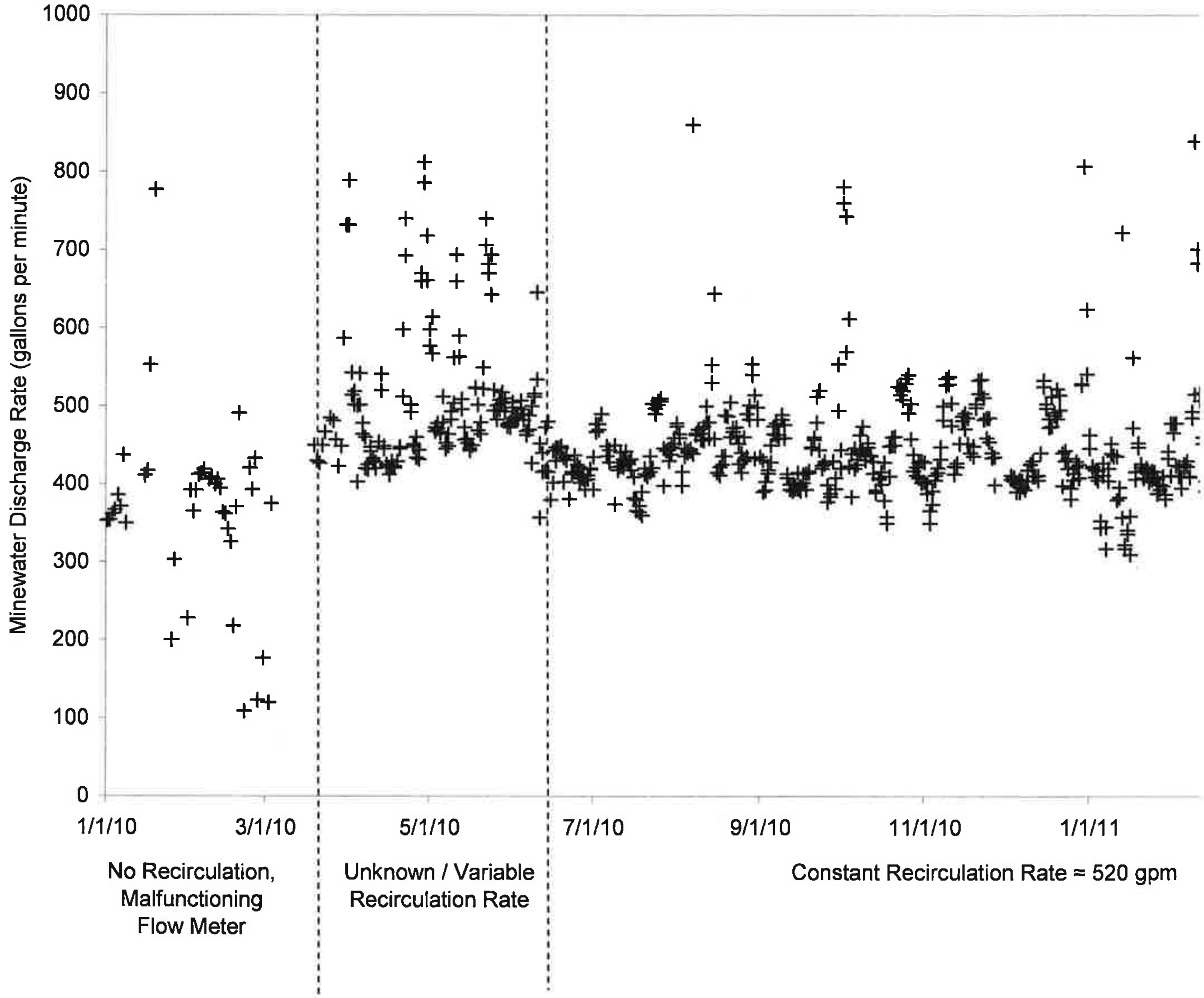

Figure 4. Minewater Discharge Rate January 2008 through May 2011.

Table 1. Mine Water Discharge Chemistry, 2008 – Present

										Iron			Aluminum		Manganese						
Date	Discharge gpm	pH (std. units)	Dissolved Oxygen (mg/L)	Spec Cond (µS/cm)	Temp (C)	Calcium, Dissolved (mg/L)	Magnesium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Potassium, Dissolved (mg/L)	Total (mg/L)	Dissolved (mg/L)	Ferrous (mg/L)	Total (mg/L)	Dissolved (mg/L)	Total (mg/L)	Dissolved (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Silica, Dissolved (mg/L)	Bicarbonate (mg/L $CaCO_3$)	Alkalini[t] Carbona[te] (mg/L CaC[O3])
1/10/08	653	8.12	8.3	--	10	--	--	--	--	0.937	--	--	--	--	--	--	--	--	--	--	--
1/21/08	--	--	--	--	--	--	--	--	--	2.204	0.161	--	--		0.138	--	--	--	--	--	--
1/28/08	653	7.9	9.3	1507	7	--	--	--	--	1.494	0.034	--	--	0.06	0.121	--	--	--	--	--	--
2/4/08	--	--	--	--	--	--	--	--	--	0.815	0.111	--	--	0.09	0.107	--	--	--	--	--	--
2/11/08	448	7.6	11.3	1446	8.5	--	--	--	--	0.765	0.036	--	--	0.05	0.109	--	--	--	--	--	--
2/18/08	448	7.92	10.1	1448	12.1	--	--	--	--	0.668	0.021	--	--	0.17	0.107	--	--	--	--	--	--
3/3/08	582	7.4	10.6	1429	10.8	--	--	--	--	1.846	0.01	--	--	0.17	0.101	--	--	--	--	--	--
3/17/08	582	8.22	10.8	1272	9.5	--	--	--	--	0.626	0.02	--	--	0.14	0.096	--	--	--	--	--	--
4/1/08	660	8.09	10.4	1279	9.7	--	--	--	--	0.653	0.027	--	--	0.14	--	--	--	--	--	--	--
4/15/08	660	7.71	10.2	1248	11.8	--	--	--	--	0.491	0.019	--	--	0.14	--	--	--	--	--	--	--
5/5/08	535	7.19	8.9	1225	12	--	--	--	--	0.433	<0.010	--	--	0.15	--	--	--	--	--	--	--
5/14/08	549	7.98	9.2	1165	12.4	--	--	--	--	0.457	0.01	--	--	0.16	--	--	--	--	--	--	--
6/1/08	528	7.77	8.9	1272	15	--	--	--	--	0.448	--	--	--	--	--	--	--	--	--	--	--
7/16/08	538	7.04	7.1	1142	12.2	--	--	--	--	0.434	--	--	--	--	--	--	--	--	--	--	--
8/8/08	--	--	--	--	--	--	--	--	--	0.546	--	--	--	--	--	--	--	--	--	--	--
9/9/08	538	8.6	8	1087	14.5	--	--	--	--	0.775	--	--	--	--	--	--	--	--	--	--	--
10/10/08	528	8.2	7.8	1010	10.9	--	--	--	--	1.335	--	--	--	--	--	--	--	--	--	--	--
11/15/08	500	8.6	8.09	1135	10	--	--	--	--	0.141	--	--	--	--	--	--	--	--	--	--	--
12/9/08	403	6.95	9.1	--	6.7	--	--	--	--	1.569	--	--	--	--	--	--	--	--	--	--	--
1/7/09	326	7.99	8.1	1000	13.7	--	--	--	--	1.783	--	--	--	--	--	--	--	--	--	--	--
2/3/09	347	7.78	7.9	1060	11	--	--	--	--	2.454	0.256	--	--	0.14	0.173	--	--	--	--	--	--
3/4/09	347	8.01	7.2	1030	12	--	--	--	--	2.23	0.51	--	--	--	--	--	--	--	--	--	--
4/6/09	292	7.9	8.6	1070	10	--	--	--	--	2.455	0.486	--	--	0.12	0.162	--	--	--	--	--	--
5/6/09	300	7.22	9.1	1010	18	--	--	--	--	2.331	<0.010	--	--	--	--	--	--	--	--	--	--
6/3/09	300	7.78	7.79	1060	14.02	--	--	--	--	2.501	0.748	--	--	--	--	--	--	--	--	--	--
7/29/09	300	7.55	<0.0	1020	15.7	--	--	--	--	2.924	0.849	--	--	--	--	--	--	--	--	--	--
8/24/09	300	7.23	8.03	1050	14	--	--	--	--	5.151	0.654	--	--	--	--	--	--	--	--	--	--
9/3/09	400	7.23	8.8	1080	13.6	--	--	--	--	3.012	0.885	--	--	0.1	0.143	--	--	--	--	--	--
10/28/09	757	6.92	8.07	1150	8.8	--	--	--	--	8.03	--	--	--	--	--	--	--	--	--	--	--
11/18/09	757	7.04	12.1	1050	11.9	--	--	--	--	3.927	--	--	--	--	--	--	--	--	--	--	--
12/16/09	431	8.12	11.68	1020	10.1	--	--	--	--	3.1	--	--	--	--	--	--	--	--	--	--	--
1/28/10	--	6.98	4.89	1010	8.1	--	--	--	--	3.0	0.9	< 0.1 (Lab)	< 0.1	< 0.1	0.14	0.14	159	--	--	381	<10
2/23/10	393	7.76	5.3	1030	10.1	--	--	--	--	3.3	1.3	0.77 (Lab)	< 0.1	< 0.1	0.13	0.13	170	--	--	379	<10
3/26/10	481	--	--	--	--	--	--	--	--	3.709	1.531	--	0.13	0.11	0.13	0.13	174	--	--	374	<10
3/30/10	587	--	--	--	--	--	--	--	--		--	1.2	--	--	--	--	--	--	--	--	--
4/12/10	454	7.55	--	--	--	99.88	55.52	34.34	8.43	3.245	1.034	1.23	0.1	<0.02	0.128	0.122	183	10.76	7.6	380	<10
4/21/10	568	6.91	6.53	1000	10.2	--	--	--	--	4.288	1.11	1.23	<0.02	<0.02	0.114	0.124	182.2	10.76	--	380	<10
5/18/10	520	6.93	5.23	1000	11	--	--	--	--	3.119	0.965	--	0.04	<0.02	0.126	0.126	183.6	--	--	382	<10
6/23/10	485	7.26	4.3	981	13.5	--	--	--	--	5.312	0.689	0.848	0.06	<0.02	0.134	0.114	170	--	--	380	<10
7/21/10	482	7.27	4.48	956	16	--	--	--	--	3.97	0.73	1.04	<0.03	<0.03	0.113	0.113	158	--	--	370	<5
8/27/10	560	7.1	4.53	554	11	100.41	55.69	35.06	8.24	3.23	0.83	1.187	<0.03	<0.03	0.113	0.113	157	10	7.4	374	<5
9/29/10	478	7.05	4.58	950	12	100.85	55.31	34.59	8.27	3.47	0.69	1.004	<0.03	<0.03	0.112	0.112	168	11	9.2	375	<5
10/29/10	487	6.97	4.35	937	11	100.2	55.17	35.88	8.27	2.81	0.61	0.912	0.06	<0.03	0.11	0.11	167	11	8.66	380	<5
11/22/10	595	7.21	6.73	939	11	97.67	54.35	34.37	8	3.19	<0.03	1.29	<0.03	<0.03	0.104	0.104	160	11	8.84	378	<5
12/17/10	549	7.5	5.63	895	10	98.65	54.3	35.79	7.96	3.29	0.07	1.018	<0.03	<0.03	0.108	0.108	156	11	8.6	386	<5
1/24/11	482	7.02	4.27	926	11	99.16	55.33	36.36	8.29	2.93	0.54	0.781	<0.03	<0.03	0.108	0.108	156	11	9.2	377	<5
2/23/11	553	7.1	5.77	955	10	104.5	57.99	35.49	8.32	2.41	0.12	0.346	<0.03	<0.03	0.113	0.11	178	11	8.97	381	<5
3/10/11	468	--	--	--	--	--	--	--	--	2.34	--	--	--	--	--	--	--	--	--	--	--
3/17/11	536	--	--	--	--	--	--	--	--	2.18	--	--	--	--	--	--	167	--	--	--	--
3/24/11	571	--	--	--	--	--	--	--	--	2.39	--	--	--	--	--	--	171	--	--	--	--
3/28/11	440	7.2	4.47	943	11	100.87	55.51	34.88	8.45	2.31	0.31	0.432	<0.03	<0.03	0.11	0.11	167	11	9.31	376	<5
3/30/11	437	7.3	--	--	--	--	--	--	--	2.36	--	--	--	--	--	--	--	--	--	--	--
4/7/11	521	--	--	--	--	--	--	--	--	2.39	--	--	--	--	--	--	172	--	--	--	--
4/14/11	502	--	--	--	--	--	--	--	--	2.25	--	--	--	--	--	--	164	--	--	--	--
4/19/11	491	--	--	--	--	--	--	--	--	2.62	--	--	--	--	--	--	164	--	--	--	--
4/26/11	457	7.1	7.15	904	10	100.06	55.89	34.22	7.98	2.55	0.46	0.703	<0.03	<0.03	0.107	0.107	180	10	8.56	365	<5
4/27/11	484	--	--	--	--	--	--	--	--	6.68	--	--	--	--	--	--	180	--	--	--	--
5/3/11	370	--	--	--	--	--	--	--	--	2.05	--	--	--	--	--	--	165	--	--	--	--
5/12/11	--	--	--	--	--	--	--	--	--	2.16	--	--	--	--	--	--	168	--	--	--	--
5/17/11	574	--	--	--	--	--	--	--	--	2.56	--	--	--	--	--	--	170	--	--	--	--

Table 2. Minewater Total Iron and Sulfate Analytical Results for Samples Analyzed by Genwal and the Division, March 2011 to May 2011

Sample Date	Total Iron (mg/L)		Sulfate (mg/L)	
	Genwal	Division	Genwal	Division
3/10/2011	2.34	1.98	na	189
3/17/2011	2.18	2.06	167	190
3/24/2011	2.39	2.28	171	187
3/30/2011	2.36	2.04	na	191
4/7/2011	2.39	2.15	172	183
4/14/2011	2.25	2.11	164	181
4/19/2011	2.62	2.43	164	171
4/27/2011	6.68	5.0	180	172
5/3/2011	2.05	2.02	165	162
5/12/2011	2.16	2.0	168	182
5/17/2011	2.56	2.33	170	188

Notes:
na = not analyzed